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THE VARIABILITY OF THE THERMOELECTRIC PYRHELIOMETER FACTOR

By IRVING F. HAND

[Weather Bureau, Washington, D. C., March 1940]

For several years pyrheliometers utilizing copper-constantan thermopiles have been used by the Weather Bureau at Washington, D. C., and the Blue Hill Observatory of Harvard University at Milton, Mass., to measure normal incidence radiation.[1] In every case the readings of the thermoelectric pyrheliometers were checked against readings of substandards, chiefly the Smithsonian silver-disk and the Marvin resistance pyrheliometers, in order to determine factors by which to multiply scale readings to obtain radiation values in gram-calories. After finding that there is a change in these factors with radiation fluctuations, we began a series of comparisons late in 1938 between our substandards and the thermoelectric pyrheliometer; and a new and longer series was commenced in March 1939, after the recording micromax potentiometer had been thoroughly adjusted by factory experts. Comparisons also were made between our substandard pyrheliometers and a vacuum thermoelectric pyrheliometer[2] registering on both a micromax potentiometer and an eye-read microammeter.

The appreciable errors, introduced by the change in resistance of the elements in the vacuum thermopile with temperature variations, induced us to change from the measurement of current to the null potentiometric method. This change is appreciable because of the relatively large ratio of the resistance of the couple to that of the total circuit; that is, the resistance of the couple is 7 ohms as compared with 8 ohms of the microammeter and less than 1 ohm of the leads, while 7 ohms is the maximum resistance which we can introduce externally and still retain proper scale deflections.

Only 14 series of comparisons were made between the substandard pyrheliometers and the vacuum thermocouple recording on a microammeter, and these give a probable error of ±4.5 percent when a single mean for a full calorie range is used as a constant factor. By drawing a line of best fit through the plotted readings, the probable error is reduced to ±2.7 percent. An attempt was made to determine the effect of free-air temperature changes, but without success.

Unquestionably the effect of the Stefan-Boltzman law enters into the cause of the varying factors; but calculations from available data fail to give results comparable with the line of best fit, and it is thought, therefore, owing to lack of sufficiently precise data on the characteristics of the alloys used, the dimensions, and other quantities, that the only practical method of obtaining the factors is through a long series of direct comparisons.

A much longer series of 337 comparisons was made between our substandard pyrheliometers and the Eppley normal incidence pyrheliometer, and 298 comparisons between the same substandard instruments and the Clark vacuum pyrheliometer, both recording on a potentiometer. Table 1 lists all comparisons and corresponding factors for both instruments; figure 1 shows a plot of the mean factors, as abscissas, against radiation values in gram calories as ordinates, for the Eppley pyrheliometer.

In the case of the Eppley pyrheliometer the probable error of a single observation from the line of best fit in the range 0.85–1.45 gram calories is ±0.37 percent, and the probable error of the means of a series of 10 is ±0.24 percent. However, if the mean value for all observations is used for a constant factor, the probable error of individual readings from this constant factor is ±1.18 percent for the same range, but somewhat larger for the entire range ordinarily covered when making normal incidence measurements from air-mass 5.0 to as close to 1.0 air mass as is practicable.

We would expect the probable error of a series to be less than that of a single observation, because radiation receipt never is uniform. Moreover, the thermoelectric records are continuous, whereas the substandard pyrheliometers give readings only every minute or every 4 minutes, depending upon the type used.

The probable errors of both instruments with various combinations are tabulated in table 2.

TABLE 1.—*Determination of factors by which to multiply scale readings on Leeds and Northrup potentiometer to obtain normal incidence radiation in gram calories*

Date and hour angle	Q	Scale (Eppley)	Factor Q/Eppley	Scale (Clark)	Factor Q/Clark	Means: Q	Means: Eppley	Means: Clark
1939								
March 3:								
3:24	1.134	46.0	.0247					
	1.133	46.0	247					
	1.118	45.0	246					
	1.123	45.5	246					
	1.134	46.0	247			1.128	0.02466	
	1.130	46.0	246					
	1.115	45.0	248					
	1.133	46.0	246					
	1.151	46.5	248					
	1.161	46.5	248			1.138	.02472	
	1.167	47.0	248					
	1.171	47.0	249					
	1.197	48 .0	249					
	1.206	49.0	246					
3:10	1.207	48.5	249			1.190	.02482	
1:21	1.405	55.5	253					
	1.389	54.5	255					
	1.383	54.0	256					
	1.380	54.0	256					
1:16	1.389	55.0	253			1.389	.02546	

[1] The first instance of this method of pyrheliometric measurement known to the writer was described by Ladislaus Gorczyński in the MONTHLY WEATHER REVIEW, 52: 299-301, June 1924.

[2] Single junction vacuum normal incidence pyrheliometer made by Leland B. Clark, of the Astrophysical Observatory of the Smithsonian Institution, Washington, D. C.

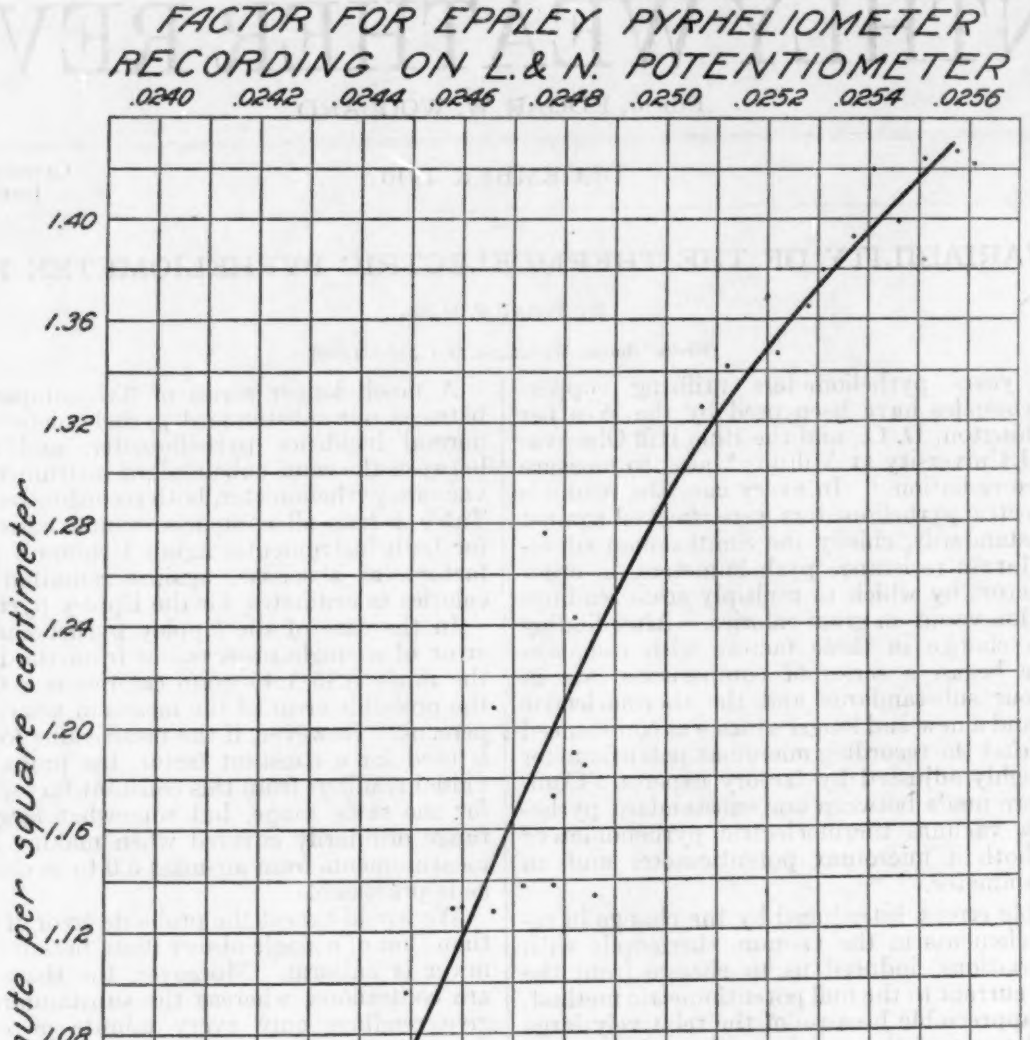


FIGURE 1.—Plot of the mean factors, as abscissas, against radiation values in gram-calories as ordinates, for the Eppley pyrheliometer.

TABLE 1.—*Determination of factors by which to multiply scale readings on Leeds and Northrup potentiometer to obtain normal incidence radiation in gram calories*—Continued

Date and hour angle	Q	Scale (Eppley)	Factor Q/Eppley	Scale (Clark)	Factor Q/Clark	Means Q	Means Eppley	Means Clark
1939								
March 7:								
3:18	1.163	46.8	249	89.4	.0130	--------	--------	--------
	1.168	47.1	248	89.5	131	--------	--------	--------
	1.158	47.0	246	89.3	130	--------	--------	--------
	1.160	47.0	247	89.6	130	--------	--------	--------
	1.174	47.2	249	89.4	131	--------	--------	--------
	1.192	47.8	249	89.2	134	--------	--------	--------
	1.192	47.8	249	89.2	134	--------	--------	--------
	1.170	47.4	247	89.5	131	--------	--------	--------
	1.176	47.5	247	89.5	131	--------	--------	--------
3:09	1.176	47.5	247	89.6	131	1.173	.02478	.01313
2:51	1.263	51.0	248	96.1	131	--------	--------	--------
	1.289	51.1	252	96.2	134	--------	--------	--------
	1.290	51.1	252	96.3	134	--------	--------	--------
	1.285	51.4	250	96.3	133	--------	--------	--------
	1.276	51.8	246	96.3	133	--------	--------	--------
	1.267	51.7	245	96.6	131	--------	--------	--------
	1.273	51.9	245	97.0	131	--------	--------	--------
	1.274	51.9	245	96.8	132	--------	--------	--------
2:43	1.266	51.7	245	96.3	131	1.276	.02476	.01332
1:48	1.367	54.5	251	101.0	135	--------	--------	--------
	1.371	54.5	252	101.5	135	--------	--------	--------
	1.378	54.5	253	102.5	135	--------	--------	--------
	1.368	54.5	252	102.0	134	--------	--------	--------
	1.361	54.0	252	101.0	135	--------	--------	--------
	1.363	54.0	254	101.0	135	--------	--------	--------
	1.364	54.5	250	101.0	135	--------	--------	--------
	1.366	54.5	251	101.5	135	--------	--------	--------
	1.371	54.5	252	101.5	135	--------	--------	--------
1:39	1.378	54.5	253	102.0	135	1.369	.02520	.01349
1:20	1,415	55.5	255	106.0	134	--------	--------	--------
	1.431	56.5	253	106.0	135	--------	--------	--------
	1.426	56.0	255	106.0	135	--------	--------	--------
	1.410	55.5	254	106.0	133	--------	--------	--------
	1.422	56.0	254	105.0	136	--------	--------	--------
	1.414	55.5	255	105.0	135	--------	--------	--------
	1.415	55.5	255	105.0	135	--------	--------	--------
	1.421	56.0	254	105.0	136	--------	--------	--------
1:11	1.425	56.5	252	105.0	136	1.420	.02541	.01348
0:59	1.410	55.0	256	105.0	135	--------	--------	--------
	1.403	55.0	255	105.0	134	--------	--------	--------
	1.404	55.0	255	105.0	137	--------	--------	--------
	1.433	45.0	256	105.0	138	--------	--------	--------
	1.441	56.0	257	105.0	138	--------	--------	--------
	1.448	56.0	258	105.0	138	--------	--------	--------
	1.433	56.0	256	105.0	137	--------	--------	--------
	1.420	55.5	256	105.0	136	--------	--------	--------
	1.414	55.5	255	105.0	135	--------	--------	--------
0:50	1.411	55.0	257	105.0	135	1.422	.02561	.01363
0:45	1.436	56.0	.0256	106.5	.0135	--------	--------	--------
	1.420	55.5	256	106.0	134	--------	--------	--------
	1.423	55.5	256	106.0	134	--------	--------	--------
	1.417	55.5	255	105.5	134	--------	--------	--------
	1.422	55.5	256	106.0	135	--------	--------	--------
	1.431	56.0	256	106.5	134	--------	--------	--------
	1.432	56.0	256	107.0	134	--------	--------	--------
	1.447	56.5	256	107.0	135	--------	--------	--------
	1,439	56.5	255	107.0	135	--------	--------	--------
0:36	1.427	56.0	255	106.5	134	1.420	.02557	.01344
0:31	1.481	57.5	257	108.0	138	--------	--------	--------
	1.441	56.5	255	106.0	136	--------	--------	--------
	1.414	55.5	255	104.0	136	--------	--------	--------
	1.441	56.5	255	106.0	136	--------	--------	--------
	1.439	56.5	255	106.0	136	--------	--------	--------
	1.420	56.0	254	105.0	135	--------	--------	--------
	1.414	55.5	255	105.0	135	--------	--------	--------
	1.407	55.0	256	104.0	135	--------	--------	--------
	1.396	55.0	254	104.0	135	--------	--------	--------
0:40	1.388	54.5	255	104.0	134	1.424	.02551	.01356
1:45	1.361	54.0	252			--------	--------	--------
	1.361	54.0	252			--------	--------	--------
	1.366	54.0	253			--------	--------	--------
	1.366	54.0	253			--------	--------	--------
	1.369	54.0	254			1.365	.02528	--------
	1.360	53.9	252			--------	--------	--------
	1.328	53.2	250			--------	--------	--------
	1.323	53.2	249			--------	--------	--------
	1.338	53.3	251			--------	--------	--------
	1.350	53.6	254			1.342	.02512	--------
					Off Scale	--------	--------	--------

TABLE 1.—*Determination of factors by which to multiply scale readings on Leeds and Northrup potentiometer to obtain normal incidence radiation in gram calories*—Continued

Date and hour angle	Q	Scale (Eppley)	Factor Q/Eppley	Scale (Clark)	Factor Q/Clark	Means Q	Means Eppley	Means Clark
1939								
March 7:								
1:45	1.371	53.9	254			--------	--------	--------
	1.363	53.9	253			--------	--------	--------
	1.345	53.4	252			--------	--------	--------
	1.333	53.0	252			--------	--------	--------
	1.323	52.9	250			1.347	.02522	--------
	1.322	52.9	250			--------	--------	--------
	1.326	53.0	250			--------	--------	--------
	1.327	53.0	250			--------	--------	--------
2:00	1.329	53.0	251			1.326	.02502	--------
2:37	1.261	50.7	249	93.4	135	--------	--------	--------
	1.267	50.7	250	93.4	135	--------	--------	--------
	1.253	50.4	249	93.0	135	--------	--------	--------
	1.240	50.1	248	92.7	134	--------	--------	--------
	1.235	50.0	247	92.8	133	--------	--------	--------
	1.239	50.0	248	92.8	134	--------	--------	--------
	1.246	50.1	249	92.7	134	--------	--------	--------
	1.247	50.1	249	92.5	135	--------	--------	--------
	1.244	50.1	248	92.4	135	--------	--------	--------
	1.232	49.8	247	92.4	133	--------	--------	--------
	1.229	49.8	247	92.6	133	--------	--------	--------
	1.240	50.0	248	92.6	134	--------	--------	--------
	1.240	50.0	248	92.6	134	--------	--------	--------
2:50	1.233	40.8	248	92.5	133	1.243	.02482	.01337
March 8:								
1:32	1.389	54.5	255	104.0	134	--------	--------	--------
	1.384	54.5	254	104.0	133	--------	--------	--------
	1.394	55.0	253	105.5	133	--------	--------	--------
	1.415	56.0	253	105.0	135	--------	--------	--------
	1.405	55.5	253	105.0	134	--------	--------	--------
	1.395	55.0	254	104.0	134	--------	--------	--------
	1.394	55.0	254	104.0	134	--------	--------	--------
	1.375	54.0	255	104.0	132	--------	--------	--------
	1.389	55.0	253	104.0	134	--------	--------	--------
1:23	1.391	55.0	253	104.0	134	1.393	.02537	.01337
0:54	1.378	54.5	253	103.0	134	--------	--------	--------
	1.379	54.5	253	103.0	134	--------	--------	--------
	1.378	54.5	253	103.0	134	--------	--------	--------
	1.381	54.5	253	103.0	134	--------	--------	--------
	1.376	54.5	253	103.0	134	--------	--------	--------
	1.368	54.0	254	103.0	133	--------	--------	--------
	1.381	54.0	256	103.0	134	--------	--------	--------
	1.390	55.0	253	103.0	135	--------	--------	--------
	1.387	55.0	252	103.0	135	--------	--------	--------
0:44	1.381	55.0	251	103.0	134	1.380	.02531	.01341
0:28	1.220	40.9	.0246	92.8	.0133	--------	--------	--------
	1.214	44.9	243	92.8	133	--------	--------	--------
	1.232	50.0	246	93.0	132	--------	--------	--------
	1.222	49.0	250	92.8	133	--------	--------	--------
	1.208	49.2	248	92.2	131	--------	--------	--------
	1.203	48.2	250	91.2	132	--------	--------	--------
	1.191	48.1	248	90.6	131	--------	--------	--------
	1.180	48.0	246	90.2	131	--------	--------	--------
	1.200	49.0	245	91.6	131	--------	--------	--------
0:39	1.214	49.8	244	92.0	132	1.208	.02466	.01319
1:14	1.194	47.8	250	88.0	136	--------	--------	--------
	1.186	47.6	249	88.0	135	--------	--------	--------
	1.182	47.6	248	88.4	134	--------	--------	--------
	1.174	47.6	247	89.2	132	--------	--------	--------
1:18	1.189	48.0	248	89.0	134	1.185	.02484	.01342
1:58	1.143	46.5	246	86.2	133	--------	--------	--------
	1.150	46.0	246	86.2	131	--------	--------	--------
	1.133	46.0	246	86.4	131	--------	--------	--------
	1.137	46.0	247	86.8	131	--------	--------	--------
	1.137	46.0	247	86.8	131	--------	--------	--------
	1.133	45.9	247	86.5	131	--------	--------	--------
	1.126	45.8	246	86.2	131	--------	--------	--------
	1.117	45.6	245	85.2	131	--------	--------	--------
	1.114	45.4	245	85.2	131	--------	--------	--------
2:07	1.111	45.4	245	84.2	132	1.130	.02460	.01313
2:30	1.153	46.4	248	85.6	135	--------	--------	--------
	1.148	46.2	248	85.6	134	--------	--------	--------
	1.136	46.1	246	85.6	133	--------	--------	--------
	1.133	46.0	246	85.6	133	--------	--------	--------
	1.136	46.0	247	85.5	133	--------	--------	--------
	1.133	46.0	246	85.3	133	--------	--------	--------
	1.123	46.0	244	85.2	132	--------	--------	--------
	1.111	45.8	243	85.0	131	--------	--------	--------
	1.108	45.3	245	84.8	131	--------	--------	--------
2:40	1.110	45.3	245	84.8	131	1.129	.02458	.01336
3:07	1.077	43.9	245	82.2	131	--------	--------	--------
	1.060	43.6	243	82.0	129	--------	--------	--------
	1.046	43.0	243	81.7	128	--------	--------	--------
	1.047	42.8	245	81.7	128	--------	--------	--------
3:11	1.041	49.6	244	81.6	128	1.054	.02440	.01288

TABLE 1.—*Determination of factors by which to multiply scale readings on Leeds and Northrup potentiometer to obtain normal incidence radiation in gram calories*—Continued

Date and hour angle	Q	Scale (Eppley)	Factor Q/Eppley	Scale (Clark)	Factor Q/Clark	Means: Q	Means: Eppley	Means: Clark
1939								
March 9:								
3:22	0.860	35.8	240	67.8	127			
	0.867	36.1	240	68.2	127			
	0.852	35.8	238	68.0	126			
	0.860	35.8	240	68.4	126			
	0.864	36.0	240	68.7	126			
	0.857	35.8	239	68.6	125			
	0.854	35.8	238	68.4	125			
	0.860	36.0	239	69.4	124			
	0.864	36.2	239	69.6	124			
	0.866	36.2	239	69.7	124	0.860	.02392	.01250
	0.912	37.7	242	71.0	129			
	0.927	37.9	245	71.9	129			
	0.927	38.0	244	71.9	129			
	0.931	38.4	243	72.1	129			
	0.938	38.8	242	72.1	130			
	0.938	39.0	241	74.0	127			
	0.944	39.3	240	74.0	128			
	0.952	39.8	239	74.5	128			
	0.957	39.8	240	74.8	128			
	0.961	40.1	240	76.0	126			
	0.968	40.4	240	75.4	128			
	0.980	40.6	241	75.4	130			
	0.983	40.8	241	75.6	130			
	0.982	40.5	242	76.9	128			
	0.980	40.4	243	77.0	127			
	0 983	40.1	245	77.2	127			
2:51	0.996	40.8	244	77.4	129	0.956	.02419	.01285
2:50	0.998	40.8	.0245	75.8	.0132			
	0.994	41.0	243	76.0	131			
	1.002	41.0	244	76.4	131			
	1.009	41.0	246	77.0	131			
	1.009	41.1	245	77.0	131			
	1.005	41.2	244	77.4	130			
	1.002	41.0	244	77.4	129			
	1.002	40.9	245	77.0	130			
	1.004	40.8	246	76.7	131			
	1.007	40.9	246	76.5	132			
	1.011	41.4	244	77.2	131			
	1.025	41.8	245	77.6	132			
	1.037	42.0	247	77.6	134			
	1.033	42.0	246	78.4	132			
	1.036	42.2	245	78.4	132			
	1.036	42.4	245	78.2	132			
	1.030	42.2	244	78.8	131			
	1.035	42.3	245	79.2	130			
	1.039	42.4	245	78.8	132			
	1.042	42.4	246	78.3	133			
	1.039	42.6	244	78.3	133			
	1.043	42.8	244	78.2	133			
	1.047	42.9	244	79.2	132			
	1.052	42.8	246	78.7	134			
	1.052	42.9	245	79.4	132	1.024	.02449	.01316
	1.055	43.2	244	78.8	134			
	1.058	43.1	246	78.6	135			
	1.061	43.4	244	78.9	134			
	1.062	43.4	244	78.9	135			
	1.059	43.3	245	79.3	134			
	1.058	43.3	244	79.8	133			
	1.056	43.2	244	80.4	131			
	1.054	43.1	245	80.5	131			
	1.057	43.1	245	80.6	131			
	1.067	43.0	248	81.1	130			
	1.076	43.4	248	81.6	132			
	1.070	43.5	246	81.8	131			
	1.067	43.5	245	82.4	130			
	1.070	43.6	245	82.5	130			
	1.070	43.7	245	82.6	130			
	1.073	43.8	245	82.7	130			
	1.077	44.0	245	82.8	130			
	1.080	44.2	244	82.4	131			
	1.081	44.4	243	81.7	132			
	1.086	44.5	244	81.9	133			
	1.093	44.7	245	82.4	133			
	1.099	44.8	245	82.4	133			
	1.103	45.1	245	82.8	133			
	1.103	45.2	244	82.9	133			
2:00	1.102	45.2	244	82.9	133	1.073	.02449	.01324
1:59	1.099	45.2	243	83.8	131			
	1.096	45.0	244	83.3	132			
	1.093	45.2	242	83.9	130			
	1.089	44.8	243	84.3	129			
	1.090	44.5	245	84.6	129			
	1.091	44.6	245	83.8	131			
	1.101	44.7	246	84.4	130			
1:52	1.107	44.8	247	84.9	130	1.096	.02444	.01302
1:22	1.122	45.1	249	84.4	133			
	1.127	45.1	250	84.4	134			
	1.127	45.0	250	84.6	133			
	1.121	45.6	246	84.7	132			
	1.133	45.6	248	84.8	134			
	1.150	45.8	251	85.3	135			

TABLE 1.—*Determination of factors by which to multiply scale readings on Leeds and Northrup potentiometer to obtain normal incidence radiation in gram calories*—Continued

Date and hour angle	Q	Scale (Eppley)	Factor Q/Eppley	Scale (Clark)	Factor Q/Clark	Means: Q	Means: Eppley	Means: Clark
1939								
March 9:	1.144	45.8	250	84.8	135			
1:22	1.126	46.1	244	84.9	133			
	1.118	45.8	244	85.4	131			
	1.117	45.8	244	85.2	131			
	1.122	45.8	245	84.8	132			
	1.140	46.1	247	85.9	133			
	1.145	46.1	248	86.2	133			
	1.140	46.2	247	86.0	133			
	1.145	46.3	247	84.9	135			
	1.148	48.3	248	85.7	134			
	1.152	46.2	249	85.8	134			
	1.159	46.4	250	85.7	135			
	1.162	46.5	250	85.6	136			
1:03	1.163	46.5	250	85.5	136	1.138	.02478	.01336
0:52	1.150	46.2	.0249	85.6	.0134			
	1.151	46.1	250	84.3	136			
	1.147	46.0	249	84.1	136			
	1.146	45.8	249	84.6	135			
	1.131	45.3	250	84.5	134			
	1.123	45.6	246	83.2	135			
	1.135	45.4	250	83.0	136			
	1.132	45.2	249	83.0	136			
	1.116	45.1	248	82.4	135			
0:43	1.108	45.1	246	82.2	135	1.134	.02486	.01352
0:37	1.090	43.8	249	79.8	137			
	1.084	43.8	248	79.8	136			
	1.075	43.8	246	79.6	135			
	1.070	43.4	247	79.6	134			
	1.071	43.3	247	79.3	135			
	1.065	43.2	247	79.2	134			
	1.062	43.2	246	79.1	134			
	1.058	43.2	245	79.1	134			
	1.051	43.1	244	79.0	133			
0:46	1.050	43.1	244	79.0	133	1.068	.02463	.01345
1:20	0.977	40.0	244	74.0	132	0.977	.02440	.01320
March 10:								
3:27	0.887	36.0	241	67.4	132			
	0.884	36.7	241	67.4	131			
	0.887	36.7	242	67.6	131			
	0.890	36.9	241	67.7	131			
	0.901	37.0	243	68.4	130			
	0.896	37.4	240	68.6	131			
	0.894	37.4	239	68.7	130			
	0.898	37.4	240	69.0	130			
	0.906	37.3	243	69.0	131			
	0.909	37.0	247	70.2	130			
	0.910	37.2	245	69.8	130			
	0.910	37.3	244	70.0	130			
	0.909	37.4	243	69.8	130			
	0.901	37.3	242	69.8	129			
	0.900	37.3	241	69.8	129			
	0.903	37.3	242	69.6	130			
	0.900	37.3	241	69.2	130			
	0.898	37.2	241	69.0	130			
	0.901	37.1	243	69.2	130			
3:01	0.905	37.1	244	69.3	131	0.900	.02422	.01303
3:06	0.929	37.9	245	71.2	131			
	0.945	38.8	244	72.0	131			
	0.957	39.0	246	73.4	130			
	0.953	39.2	243	73.4	130			
	0.944	38.8	243	73.3	129			
	0.947	38.8	244	72.8	130			
	0.946	38.8	244	73.0	130			
	0.957	39.2	244	73.4	129			
	0.978	39.8	246	74.8	131			
2:57	0.967	39.9	248	74.8	132	0.954	.02447	.01304

TABLE 2.—*Probable errors of individual readings, and of means from lines of best fit and from means of all*

	Probable errors: Range 0.85–1.45 gr.-cal.			Probable errors: Range 0.50–1.50 gr.-cal.		
	Potentiometer		Clark with micro-ammeter	Potentiometer		Clark with micro-ammeter
	Eppley	Clark		Eppley	Clark	
Means from line (variable factor)	±0.24	±0.84	±1.81	±0.40	±1.40	±3.02
Individual readings from line (variable factor)	±0.37	±0.92		±0.62	±1.53	
Means from mean of all (constant factor)	±1.18	±1.31	±2.00	±1.97	±2.18	±4.48

These small probable errors from the line of best fit unquestionably show the need for using variable factors rather than a constant factor. In fact they are as close as would be expected with the regular substandard instruments for the following reasons:

(1) Normal incidence radiation never is uniform at sea level, owing chiefly to turbidity. Waviness therefore in a normal incidence curve, although slight on the best of days, is natural.

(2) In the operation of the Smithsonian silver-disk pyrheliometer the shutter is open for 2 minutes, then closed for 2 minutes. The alternations with the Marvin resistance pyrheliometer occur every minute. It is conceivable under adverse conditions that the shutter might be open during low radiation receipt, or that these conditions might be reversed. It is obvious that an error is introduced when comparing such an instrument against one that gives instantaneous and continuous readings.

(3) Owing to the personal equation it is necessary for each user of a Smithsonian or a Marvin pyrheliometer to personally read the instrument when checking against Smithsonian standards at the Astrophysical Observatory. A change of observers of necessity introduces another small source of error.

(4) While the design of all instruments here mentioned calls for an angular opening of 5°43′, in practical construction it mechanically is impossible to adhere to these measurements perfectly. As the annulus about the sun is by far the brightest portion of the sky, any increase or dimunition of the diameter of this annulus, even very slight, creates an error which is particularly appreciable on hazy days.

(5) The addition of a highly polished thin quartz or glass window over the receiving end of the Eppley and Clark pyrheliometers changes the spectral distribution of energy received on the thermoelectric surfaces enough to produce another small error.

(6) The receiving surfaces of all the pyrheliometers, especially those without sealed windows, undergo slight changes in their absorption coefficients owing to dust and other extraneous material falling upon their surfaces.

(7) Any recording mechanism lacks 100 percent precision owing to several factors, among which may be cited (*a*), nonuniform scale divisions; (*b*), incorrect setting of the zero and pen; (*c*), change in length and width of paper because of humidity variations; (*d*), slight changes in the e. m. f. of the standard cell used with potentiometers; (*e*), irregular rotation of the record roll; (*f*), zero shift for a number of reasons; and (*g*), the gradual lowering of the e. m. f. of the operating battery between checks against the standard cell.

(8) Rapid temperature changes of the free air, and winds of appreciable velocity, vitiate slightly the readings of all phyrheliometers of the types here mentioned.

As previously stated, only those readings made after the potentiometer was thoroughly adjusted to the highest practical efficiency were used in these comparisons. After this adjustment the instrument gave extraordinarily good results as shown by a continuous record, for more than 100 hours, of the e. m. f. generated by the vacuum thermocouple when receiving its energy from a well-seasoned lamp in series with a constant voltage regulator.

In order to minimize errors of paper shrinkage and expansion, a special type of record paper is used which has a low coefficient of expansion.

Although the potentiometer automatically balances the dry cells against the standard cell every 43 minutes, we also make this balance manually immediately preceding each series.

All the other instruments were thoroughly checked and placed in first-class condition before the calibrations. The Smithsonian silver-disk pyrheliometer was checked against Smithsonian standards at the Astrophysical Observatory, and used only twice before the tests; all instruments were realigned, and indicator points re-etched to insure their correct setting on the sun; the Marvin pyrheliometer was checked against the silver-disk; the signal-clock was regulated to run at a uniform rate; the microammeter was tested at the National Bureau of Standards and returned to the factory for replacement of a faulty bearing, after which it was calibrated at the Bureau, and a table giving the true values in microamperes of the scale readings was used to reduce the observations.

Upon first thought it might appear that the logical method of making these tests would be to run the two thermoelectric pyrheliometers against a standard artifical source of radiation. Practical limitations to date have prevented much work along this line, although some tests were made with the vacuum thermocouple at the Bureau of Standards; these were meager owing to lack of a light source of sufficient energy. Moreover, it is impossible practically to obtain a point-source of light; and as yet no artifical source of energy approximates closely the spectral distribution of solar energy.

Attempts to insure a high degree of accuracy have in the past so complicated the apparatus and rendered it so expensive that we have had to limit sharply the number of solar observational stations. It is thought that the newer type of apparatus will relieve this situation. Without doubt the utmost in precision is required in many special researches; but in the case of the Weather Bureau, lack of personnel and equipment prohibit the general use of precision apparatus in the field, although we maintain such instruments at our central observatory, and for general radiation climatology, high precision is not necessary.

Thermoelectric pyrheliometers are especially well adapted for measuring the red and yellow components between 0.61 and 0.51 μ [3] and have been used for this purpose by both this Bureau and the Blue Hill Meteorological Observatory.

Upon completion of the tests, the manufacturers immediately took steps to redesign the thermopile, particularly as to spacing of the elements, so as to decrease the variability of the factor values. While preliminary tests on one of these new pyrheliometers show a marked improvement in performance, the data obtained so far are too meager to give definite results.

[3] Kimball, Herbert H. Determinations of atmospheric turbidity and watervapor content. MONTHLY WEATHER REVIEW 64: 1–5, 1936.

Kimball, Herbert H. and Hand, Irving F. The use of glass color screens in the study of atmospheric depletion of solar radiation. Monthly Weather Review 61: 80–83, 1933.

TABLE 3.—*Comparison between the constant factor and the variable factors of the Eppley pyrheliometer*

(1) Scale[1]	(2) Factor	(3) Gram-calories (1)+(2)	(4) Gram-calories 0.0249 ×(1)	(5) Percent departure of (4) from (3)	(6) Corresponding millivolts
21.0	0.0234	0.491	0.523	+6.5	0.61
23.1	235	.545	.575	+5.9	.67
25.3	236	.597	.630	+5.5	.74
27.5	237	.652	.685	+5.1	.81
29.6	238	.704	.737	+4.7	.88
31.7	239	.758	.789	+4.1	.95
33.7	240	.809	.839	+3.7	1.02
35.8	241	.863	.891	+3.2	1.08
37.8	242	.915	.941	+2.8	1.14
39.8	243	.967	.991	+2.5	1.19
41.4	244	1.010	1.031	+2.1	1.25
43.1	245	1.056	1.073	+1.6	1.31
44.9	246	1.105	1.118	+1.2	1.36
46.9	247	1.158	1.168	+0.9	1.41
48.6	248	1.205	1.210	+0.4	1.45
50.1	249	1.247	1.247	0	1.49
51.4	250	1.285	1.280	−0.4	1.53
52.5	251	1.318	1.307	−0.7	1.57
53.5	252	1.348	1.332	−1.2	1.61
54.4	253	1.376	1.355	−1.5	1.64
55.4	254	1.407	1.379	−2.0	1.67
56.2	255	1.433	1.399	−2.3	1.70
56.9	256	1.457	1.417	−2.7	1.72
57.6	257	1.480	1.434	−3.2	1.74
58.2	258	1.502	1.449	−3.5	1.76
59.0	259	1.528	1.469	−3.8	1.78
59.7	260	1.552	1.487	−4.2	1.80

[1] The recording micromax potentiometer used for this test has a full-scale deflection of 3 millivolts; it therefore is necessary to shift to its alternate 15-milivolt circuit when the needle reaches 100 on the scale.

The probable errors of the values in column 3 do not exceed ±0.3 percent.

Factors to reduce scale readings on potentiometer recording e. m. f. generated by Clark thermoelectric pyrheliometer

Potentiometer	Factors	Gram-calories	Potentiometer	Factors	Gram-calories
Scale readings: [1]			Scale readings:		
40.5	0.0126	0.510	81.8	132	1.080
46.9	127	.596	88.7	133	1.180
54.7	128	.700	98.5	134	1.320
62.0	129	.800	105.2	135	1.419
70.0	130	.910	109.0	136	1.482
76.3	131	1.000	114.0	137	1.562

[1] With potentiometer having full scale deflection of 3 millivolts it is necessary to shift to the 15-millivolt scale when the needle approaches the top of the scale.

Our conclusions are:

(1) Provided factors are determined according to methods here described, thermoelectric pyrheliometers are excellent for laboratory use in making routine measurements with a precision as good as that obtained with a Marvin pyrheliometer, and only slightly under the precision attained with the Smithsonian silver-disk pyrheliometer.

(2) The advantages of the use of this type of instrument are manifold; first, a saving of at least 75 percent in the observer's time; second, the readings are continuous; and third, the simplicity of the whole apparatus eliminates much of the trouble experienced with the accessories necessary for the Marvin pyrheliometer.

(3) The vacuum type is ideal for field use when used with a portable potentiometer, especially when weight is an important factor, as for example, when measurements are desired on high, poorly accessible mountain tops, because the whole pyrheliometer weighs less than 1 pound.

(4) The vacuum pyrheliometer assumes equilibrium within six seconds after opening the shutter; the copper-constantan type requires about 20 seconds to reach equilibrium.

(5) The probable errors are slightly less with the non-vacuum type.

(6) A portable precision eye-read potentiometer is recommended for field use rather than a microammeter, as the former eliminates practically all errors arising from changes in resistance of various units in the electrical circuit.

Additional comparisons made in subzero weather early in 1941 between the Smithsonian silver disk, the Clark vacuum type and the new Eppley pyrheliometers show (1) much less variation in the factors for the new Eppley pyrheliometers with widely-spaced elements, and (2) a slight free-air temperature effect; that is, all the thermoelectric pyrheliometers tested show greater efficiency with very low free-air temperatures.

ADJUSTMENT OF AIRPORT STATION-PRESSURE RECORDS TO FORMER CITY STATION ELEVATION

By W. W. REED

[Weather Bureau, Washington, D. C., January 1941]

In the installation of mercurial barometers at the airports, the tables for reduction of station pressure to sea level were based in most cases on a station elevation corresponding exactly, or very nearly, to the elevation of the ivory point of the barometer, or to the level 8 feet above the landing field. In only a relatively few cases was the adopted station elevation made to coincide with the station elevation at the city office.

At city offices established prior to 1900, the practice has been followed since the beginning of that year of maintaining a single "station elevation" by applying a "removal correction" whenever the barometer was moved to a different elevation from that existing on January 1, 1900, so that the "station pressures" pertained to the actual elevation as of that date. Thus the adopted "station elevation" corresponded to the actual elevation of the ivory point of the barometer at the beginning of the current century. At city offices established subsequent to January 1, 1900, the adopted "station elevation" was almost invariably the actual elevation of the barometer when the station was first established. Under this system, records of "station pressure" at city offices have been directly comparable since the dates in question by virtue of the fact the data were pertinent to a single "station elevation."

However, where city offices were closed or consolidated with the airport stations, the changes in elevation were so considerable in many cases that it was inadvisable to attempt the employment of a "removal correction" and the airport "station elevations" were maintained.

Beginning with July 1939, and prior thereto at several stations, the records of pressure at most of the airports were made official for synoptic purposes and published in the MONTHLY WEATHER REVIEW. This procedure introduced into the homogeneity of pressure records breaks that range in value from a few thousandths of an inch, insignificant for practical purposes, to more than 0.50 inch locally in winter. In view of the need for homogeneity in respect to elevation in the study of pressure trends, action has been taken to prepare adjustments for

the airport station pressures to reduce them to the former city office station elevation. However, separate records of "station pressure" pertinent to the originally adopted airport "station elevation" are still maintained.

The following table gives airport pressure readings corrected so as to represent mean monthly station pressures for the old City Office station elevation in order to extend the former homogeneous series over the interruption to September 1940, when the REVIEW began to carry data that meet the requirement noted above. In printing the data the first figure of the whole number of inches has been omitted and only the last figures and the decimal are shown. The first figure of the whole number is 3 for zero in the tens place and 2 in all other cases. Even with these adjustments applied, future data will not be strictly comparable with the 1900–1939–40 series, but the divergences will, in general, be small.

Station pressures at Airport adjusted to the old City Office elevation

Stations	January	February	March	April	May	June	July	August	September	October	November	December
Abilene, Tex. (1,750–1,738 ft.):												
1939							8.15	8.15	8.18	8.22	8.40	8.23
1940	8.35	8.16	8.10	8.09	8.12	8.12	8.19	8.15				
Albany, N. Y. (292–97 ft.):												
1938						9.86	9.84	9.85	9.90	9.99	0.02	9.95
1939	9.91	9.97	9.96	9.82	9.83	9.85	9.84	9.86	9.91	9.90	0.06	9.74
1940	9.90	9.86	9.83	9.83	9.81	9.77	9.90	0.00				
Albuquerque, N. Mex. (5,314–4,972 ft.):												
1939								5.10	5.12	5.11	5.20	5.12
1940	5.07	5.02	4.98	4.98	5.04	5.04	5.12	5.12				
Amarillo, Tex. (3,604–3,676 ft.):												
1939							6.30	6.30	6.32	6.30	6.45	6.28
1940	6.32	6.20	6.16	6.18	6.24	6.25	6.31	6.31				
Atlanta, Ga. (976–1,173 ft.):												
1934												8.90
1935	8.90	8.86	8.86	8.70	8.79	8.78	8.80	8.78	8.80	8.94	8.86	8.87
1936	8.79	8.83	8.69	8.83	8.83	8.72	8.77	8.83	8.83	8.85	8.91	8.93
1937	8.92	8.81	8.78	8.74	8.78	8.76	8.81	8.84	8.82	8.81	8.87	8.92
1938	8.83	8.96	8.82	8.84	8.76	8.82	8.80	8.85	8.81	8.87	8.91	8.87
1939	8.85	8.86	8.86	8.78	8.79	8.81	8.79	8.77	8.83	8.86	8.97	8.78
1940	8.86	8.75	8.74	8.75	8.72	8.80	8.87	8.78				
Augusta, Ga. (426–182 ft.):												
1939							9.79	9.79	9.84	9.88	0.02	9.84
1940	9.93	9.81	9.79	9.70	9.74	9.81	9.88	9.79				
Austin, Tex. (621–605 ft.):												
1939							9.32	9.31	9.34	9.41	9.59	9.43
1940	9.57	9.37	9.32	9.28	9.30	9.28	9.37	9.30				
Baker, Oreg. (3,373–3,471 ft.):												
1939							6.46	6.46	6.47	6.53	6.62	6.51
1940	6.50	6.38	6.42	6.44	6.45	6.46	6.44	6.46				
Baltimore, Md. (16–123 ft.):												
1939							9.85	9.84	9.92	9.92	0.08	9.79
1940	9.95	9.83	9.84	9.84	9.78	9.81	9.92	9.96				
Birmingham, Ala. (630–700 ft.):												
1939							9.28	9.24	9.31	9.36	9.50	9.31
1940	9.43	9.28	9.26	9.25	9.23	9.28	9.34	9.26				
Bismarck, N. Dak. (1,660–1,677 ft.):												
1939							8.15	8.16	8.17	8.17	8.36	8.18
1940	8.39	8.26	8.24	8.23	8.21	8.15	8.21	8.24				
Boise, Idaho (2,705–2,739 ft.):												
1939							7.12	7.12	7.15	7.23	7.36	7.27
(2,858–2,739 ft.):												
1940	7.26	7.14	7.15	7.14	7.13	7.11	7.10	7.12				
Boston, Mass. (29–124 ft.):												
1936	9.77	9.90	9.78	9.85	9.85	9.77	9.73	9.87	9.96	9.93	9.86	0.09
1937	0.11	9.79	9.70	9.87	9.80	9.77	9.82	9.92	9.90	9.90	9.88	9.93
1938	9.90	0.01	9.83	9.88	9.78	9.84	9.83	9.82	9.87	9.94	9.98	9.90
1939	9.83	9.93	9.90	9.78	9.82	9.84	9.82	9.85	9.89	9.86	9.97	9.65
1940	9.80	9.75	9.74	9.79	9.81	9.75	9.88	9.99				
Brownsville, Tex. (20–57 ft.):												
1939							9.88	9.86	9.87	9.94	0.11	0.00
1940	0.11	9.93	9.87	9.82	9.86	9.82	9.91	9.84				
Buffalo, N. Y. (706–768 ft.):												
1939							9.15	9.16	9.20	9.18	9.37	9.02
1940	9.16	9.16	9.11	9.14	9.09	9.08	9.24	9.27				
Charlotte, N. C. (769–779 ft.):												
1939							9.18	9.17	9.23	9.25	9.39	9.16
1940	9.25	9.14	9.15	9.15	9.10	9.17	9.26	9.20				

Station pressures at Airport adjusted to the old City Office elevation—Continued

Stations	January	February	March	April	May	June	July	August	September	October	November	December
Chattanooga, Tenn. (688–762 ft.):												
1939							9.20	9.18	9.24	9.29	9.43	9.23
1940	9.34	9.20	9.19	9.17	9.14	9.21	9.29	9.20				
Cheyenne, Wyo. (6,144–6,094 ft.):												
1935									4.10	4.04	3.99	3.97
1936	3.84	3.74	3.84	3.98	4.02	4.04	4.11	4.12	4.06	4.07	4.13	3.90
1937	3.76	3.84	3.93	3.88	4.00	4.05	4.12	4.12	4.11	4.05	3.99	3.95
1938	3.93	3.96	3.81	3.94	3.94	4.05	4.13	4.11	4.15	4.07	3.94	3.94
1939	3.86	3.81	3.94	3.97	3.97	3.98	4.11	4.11	4.10	4.02	4.14	3.99
1940	3.95	3.89	3.89	3.92	4.04	4.04	4.13	4.13				
Cincinnati, Ohio (497–627 ft.):												
1939							9.31	9.31	9.35	9.30	9.58	9.30
1940	9.45	9.34	9.31	9.29	9.24	9.29	9.41	9.36				
Cleveland, Ohio (805–762 ft.):												
1939							9.17	9.17	9.21	9.21	9.40	9.08
1940	9.22	9.18	9.14	9.16	9.08	9.11	9.26	9.25				
Columbia, Mo. (785–784 ft.):												
1939							9.12	9.13	9.17	9.18	9.44	9.17
1940	9.36	9.18	9.13	9.10	9.10	9.11	9.22	9.17				
Columbia, S. C. (225–347 ft.):												
1939											9.86	9.65
1940	9.74	9.63	9.62	9.62	9.57	9.64	9.71	9.64				
Columbus, Ohio (833–822 ft.):												
1930							9.12	9.11	9.15	9.18	9.36	9.67
1940	9.21	9.12	9.09	9.09	9.03	9.08	9.21	9.18				
Concord, N. H. (346–289 ft.):												
1940			9.57	9.63	9.64	9.57	9.70	9.81				
Corpus Christi, Tex. (44–20 ft.):												
1939							9.92	9.92	9.93	0.00	0.18	0.05
1940	0.18	9.98	9.93	9.88	9.91	9.88	9.97	9.89				
Dallas, Tex. (488–512 ft.):												
1939							9.40	9.38	9.42	9.50	9.70	9.51
1940	9.68	9.45	9.39	9.36	9.39	9.38	9.46	9.40				
Davenport, Iowa (594–606 ft.):												
1940						9.26	9.40	9.36				
Denver, Colo. (5,332–5,292 ft.):												
1939							4.90	4.81	4.80	4.75	4.89	4.74
1940	4.73	4.64	4.64	4.66	4.77	4.76	4.84	4.83				
Des Moines, Iowa (963–860 ft.):												
1939							9.03	9.04	9.06	9.04	9.32	9.05
1940	9.25	9.10	9.06	9.03	9.00	8.98	9.09	9.08				
Detroit, Mich. (626–730 ft.):												
1934	9.26	9.40	9.32	9.15	9.23	9.11	9.18	9.24	9.24	9.27	9.28	9.27
1935	9.34	9.24	9.20	9.18	9.26	9.13	9.20	9.22	9.25	9.37	9.30	9.26
1936	9.18	9.24	9.07	9.22	9.27	9.16	9.18	9.22	9.27	9.26	9.26	9.36
1937	9.34	9.16	9.23	9.15	9.20	9.16	9.19	9.2[illegible]	9.29	9.22	9.23	9.29
1938	9.18	9.36	9.13	9.21	9.14	9.21	9.18	9.23	9.23	9.32	9.26	9.22
1939	9.17	9.22	9.26	9.14	9.18	9.17	9.20	9.19	9.24	9.22	9.42	9.09
1940	9.24	9.23	9.19	9.21	9.11	9.13	9.30	9.30				
Elkins, W. Va. (2,006–1,947 ft.):												
1939							8.01	8.02	8.06	8.05	8.16	7.89
1940	7.96	7.90	7.89	7.91	7.90	7.98	8.10	8.07				
El Paso, Tex. (3,916–3,778 ft.):												
1939							6.18	6.17	6.19	6.22	6.32	6.24
1940	6.23	6.15	6.10	6.10	6.13	6.12	6.20	6.19				
Erie, Pa. (737–714 ft.):												
1940							9.32	9.32				
Fort Wayne, Ind. (828–857 ft.):												
1930								9.08	9.11	9.10	9.31	8.99
1940	9.13	9.08	9.05	9.06	8.97	9.02	9.17	9.13				
Fort Worth, Tex. (706–679 ft.):												
1930							9.24	9.22	9.26	9.33	9.53	9.34
1940	9.51	9.28	9.22	9.20	9.23	9.22	9.29	9.24				
Fresno, Calif. (282–327 ft.):												
1939							9.52	9.50	9.53	9.66	9.78	9.77
1940	9.73	9.73	9.68	9.64	9.55	9.48	9.55	9.52				
Galveston, Tex. (9–54 ft.):												
1930							9.92	9.90	9.92	9.99	0.14	0.02
1940	0.15	9.96	9.92	9.88	9.90	9.87	9.96	9.87				
Grand Rapids, Mich. (689–707 ft.):												
1939							9.21	9.20	9.24	9.22	9.44	9.11
1940	9.24	9.25	9.20	9.22	9.10	9.13	9.30	9.28				
Harrisburg, Pa. (351–374 ft.):												
1939	9.63	9.72	9.67	9.55	9.58	9.59	9.58	9.58	9.65	9.66	9.80	9.51
1940	9.65	9.56	9.56	9.56	9.51	9.53	9.66					
Hartford, Conn. (43–159 ft.):												
1939							9.79	9.80	9.86	9.84		
(21–159 ft.):												
1939											9.86	9.65
1940	9.81	9.74	9.74	9.77	9.76	9.73	9.85	9.95				

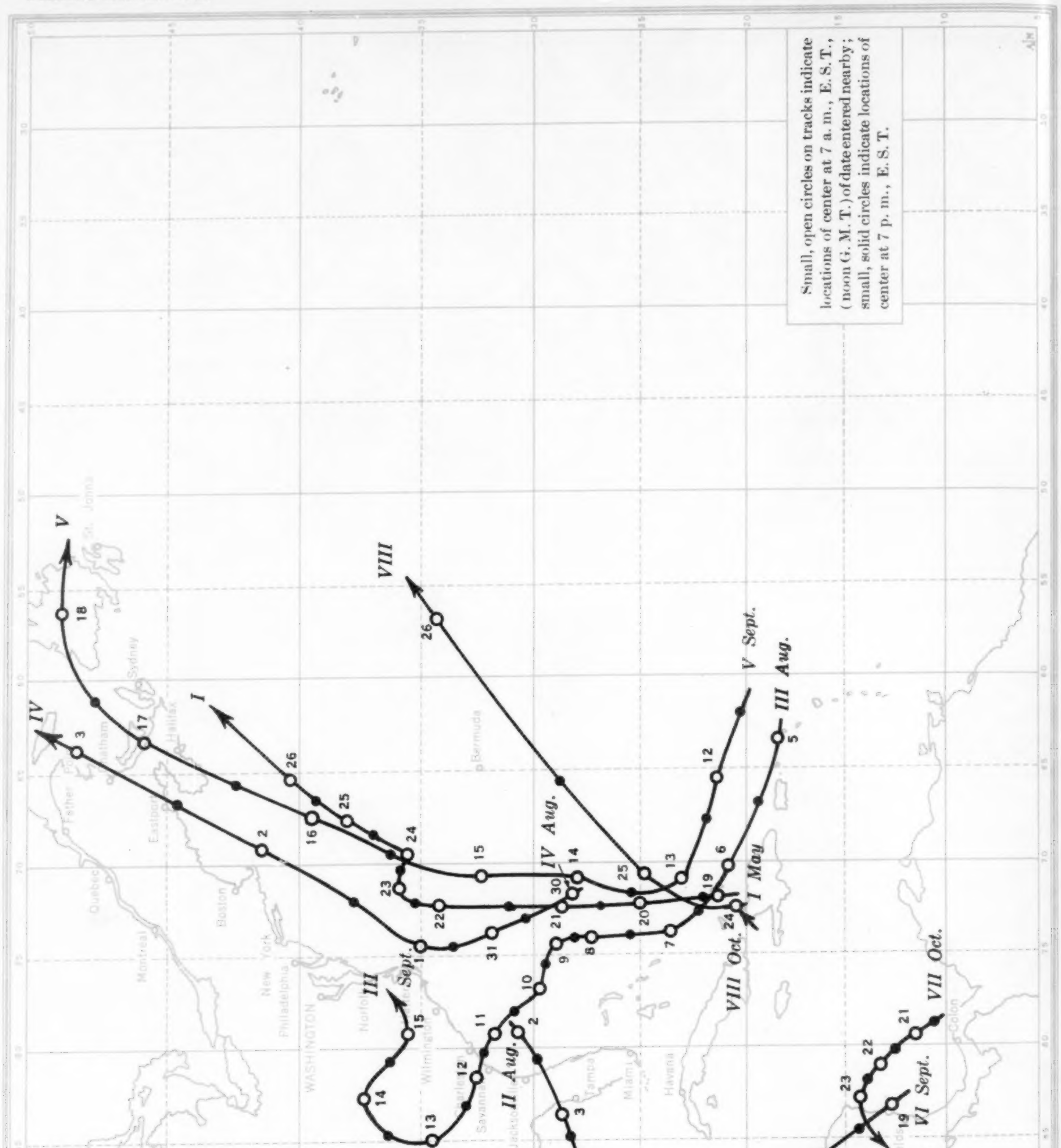
Station pressures at Airport adjusted to the old City Office elevation—Continued

Stations	January	February	March	April	May	June	July	August	September	October	November	December
Helena, Mont. (3,898–4,124 ft.):												
1940					5.82	5.81	5.83	5.85				
Houston, Tex. (62–138 ft.):												
1939							9.83	9.81	9.83	9.81	0.07	9.93
1940	0.06	9.86	9.83	9.79	9.81	9.78	9.87	9.78				
Huron, S. Dak. (1,289–1,301 ft.):												
1939							8.54	8.56	8.57	8.57	8.80	8.60
1940	8.80	8.67	8.62	8.58	8.58	8.51	8.58	8.62				
Indianapolis, Ind. (808–823 ft.):												
1939							9.10	9.10	9.14	9.16	9.37	9.08
1940	9.22	9.12	9.09	9.08	9.02	9.07	9.20	9.14				
Jacksonville, Fla. (31–43 ft.):												
1940							0.04	9.93				
Kansas City, Mo. (750–963 ft.):												
1934	9.08	9.16	9.08	8.95	8.96	8.85	8.90	8.94	8.95	9.02	8.97	9.08
1935	9.11	9.11	8.90	8.90	8.93	8.88	8.96	8.94	8.99	9.08	9.07	9.10
1936	9.02	9.03	8.84	8.99	8.98	8.89	8.91	8.91	8.94	9.02	9.14	9.07
1937	9.07	9.00	9.05	8.84	8.92	8.91	8.93	8.96	9.01	9.00	9.09	9.10
1938	9.01	9.10	8.83	8.93	8.85	8.96	8.93	8.95	8.99	9.03	8.99	9.02
1939	8.93	8.99	9.00	8.93	8.89	8.87	8.91	8.92	8.96	8.96	9.23	8.97
1940	9.18	8.98	8.92	8.90	8.91	8.90	8.99	8.97				
Key West, Fla. (11–21 ft.):												
1939							0.00	9.96	9.95	9.93	0.03	0.04
1940	0.07	0.02	9.97	9.99	9.95	9.98	0.02	9.96				
Knoxville, Tenn. (980–995 ft.):												
1939							8.96	8.95	9.01	9.04	9.18	8.97
1940	9.07	8.94	8.93	8.92	8.89	8.97	9.05	8.97				
La Crosse, Wis. (672–714 ft.):												
1939							9.20	9.19	9.22	9.18	9.46	9.17
1940	9.35	9.29	9.24	9.22	9.13	9.11	9.26	9.25				
Little Rock, Ark. (265–357 ft.):												
1939							9.59	9.57	9.61	9.69	9.89	9.67
1940	9.85	9.64	9.60	9.56	9.58	9.58	9.66	9.60				
Los Angeles, Calif. (512–338 ft.):												
1940			9.66	9.63	9.58	9.56	9.60	9.57				
Louisville, Ky. (545–525 ft.):												
1939							9.42	9.42	9.46	9.50	9.70	9.44
1940	9.59	9.45	9.43	9.39	9.36	9.40	9.52	9.45				
Macon, Ga. (464–370 ft.):												
1939							9.60	9.58	9.63	9.68	9.81	9.64
1940	9.74	9.62	9.59	9.60	9.54	9.62	9.68	9.58				
Madison, Wis. (866–974 ft.):												
1939										8.93	9.18	8.86
1940	9.01	8.98	8.95	8.95	8.85	8.86	9.03	9.00				
Memphis, Tenn. (284–399 ft.):												
1939							9.55	9.52	9.58	9.65	9.83	9.61
1940	9.78	9.58	9.55	9.51	9.53	9.55	9.62	9.56				
Meridian, Miss. (310–375 ft.):												
1939							9.61	9.56	9.62	9.69	9.83	9.66
1940	9.80	9.62	9.60	9.58	9.57	9.60	9.65	9.58				
Miami, Fla (12–25 ft.):												
1940							0.04	9.96				
Miles City, Mont. (2,634–2,371 ft.):												
1939							7.45	7.48	7.49	7.49	7.64	7.50
1940	7.67	7.48	7.47	7.51	7.50	7.44	7.47	7.49				
Milwaukee, Wis. (698–681 ft.):												
1939							9.25	9.24	9.28	9.24	9.50	9.17
1940	9.32	9.30	9.26	9.26	9.15	9.16	9.34	9.30				
Minneapolis, Minn. (838–919 ft.):												
1938				8.94	8.88	8.97	8.94	8.96	9.03	9.01	8.97	8.99
1939	8.93	8.99	9.04	8.94	8.90	8.88	8.96	8.96	8.98	8.94	9.21	8.94
1940	9.13	9.07	9.03	9.00	8.93	8.89	9.03	9.03				
Missoula, Mont. (3,189–3,263 ft.):												
1939							6.65	6.66	6.66	6.69	6.82	6.69
1940	6.75	6.55	6.59	6.62	6.65	6.64	6.63	6.65				
Mobile, Ala. (29–57 ft.):												
1939											0.15	0.01
1940	0.13	9.98	9.95	9.94	9.91	9.94	9.99	9.91				
Montgomery, Ala. (237–218 ft.):												
1939							9.77	9.73	9.79	9.85	9.99	9.82
1940	9.94	9.80	9.77	9.76	9.73	9.78	9.83	9.74				
Moorhead, Minn. (899–940 ft.):												
1939							8.90	8.90	8.92	8.91	9.14	8.94
1940	9.16	9.07	9.04	9.00	8.78	8.67	8.98	9.01				
Nashville, Tenn. (605–546 ft.):												
1939							9.40	9.39	9.44	9.50	9.67	9.44
1940	9.59	9.42	9.40	9.37	9.36	9.40	9.49	9.42				

Station pressures at Airport adjusted to the old City Office elevation—Continued

Stations	January	February	March	April	May	June	July	August	September	October	November	December
New Haven, Conn. (13–107 ft.):												
1939							9.86	9.87	9.94	9.91	0.04	9.73
1940	9.88	9.76	9.82	9.84	9.82	9.80	9.92	.02				
New Orleans, La. (30–53 ft.):												
1939							9.94	9.91	9.94	0.00	0.14	0.02
1940	.14	9.97	9.94	9.93	9.92	9.92	9.98	9.90				
Norfolk, Va. (30–91 ft.):												
1940							9.98	9.97				
North Platte, Nebr. (2,787–2,821 ft.):												
1939							7.04	7.06	7.08	7.05	7.26	7.08
1940	7.18	7.03	6.99	7.00	7.05	7.01	7.06	7.09				
Oklahoma City, Okla. (1,304–1,214 ft.):												
1939							8.67	8.66	8.70	8.74	8.97	8.75
1940	8.92	8.70	8.64	8.62	8.66	8.66	8.72	8.69				
Omaha, Nebr. (982–1,105 ft.):												
1935						8.72	8.79	8.78	8.82	8.92	8.91	8.93
1936	8.88	8.90	8.68	8.85	8.81	8.74	8.74	8.76	8.78	8.86	8.88	8.89
1937	8.91	8.83	8.91	8.68	8.76	8.76	8.78	8.79	8.86	8.85	8.91	8.93
1938	8.86	8.96	8.68	8.78	8.71	8.79	8.77	8.78	8.84	8.85	8.82	8.86
1939	8.76	8.85	8.86	8.78	8.72	8.70	8.76	8.79	8.81	8.79	9.07	8.83
1940	9.03	8.86	8.80	8.78	8.78	8.74	8.82	8.83				
Peoria, Ill. (662–609 ft.):												
1939							9.32	9.32	9.36	9.36	9.61	9.32
1940	9.48	9.38	9.34	9.31	9.25	9.26	9.41	9.36				
Philadelphia, Pa. (19–114 ft.):												
1940							9.92	9.98				
Phoenix, Ariz. (1,112–1,107 ft.):												
1939							8.66	8.66	8.72	8.77	8.86	8.90
1940	8.86	8.84	8.74	8.71	8.65	8.61	8.68	8.67				
Pittsburgh, Pa. (1,273–842 ft.):												
1936	9.09	9.15	8.97	9.11	9.16	9.03	9.06	9.12	9.16	9.18	9.17	9.29
1937	9.26	9.09	9.08	9.04	9.10	9.05	9.11	9.17	9.20	9.14	9.19	9.22
1938	9.11	9.26	9.07	9.12	9.06	9.12	9.09	9.14	9.12	9.23	9.22	9.15
1939	9.10	9.16	9.14	9.05	9.09	9.09	9.10	9.10	9.14	9.16	9.32	9.02
1940	9.16	9.08	9.06	9.07	9.02	9.05	9.19	9.18				
Portland, Maine (63–103 ft.):												
1940							9.88	9.99				
Portland, Oreg. (39–154 ft.):												
1939							9.86	9.83	9.85	9.94	9.99	9.86
1940	9.87	9.76	9.85	9.90	9.86	9.89	9.87	9.86				
Providence, R. I. (39–154 ft.):												
1939							9.81	9.82	9.88	9.84	9.95	9.64
1940	9.79	9.73	9.73	9.77	9.78	9.74	9.87	9.97				
Pueblo, Colo. (4,806–4,600 ft.):												
1939							5.33	5.34	5.34	5.29	5.45	5.30
1940	5.31	5.21	5.18	5.21	5.30	5.28	5.35	5.36				
Raleigh, N. C. (358–376 ft.):												
1939							9.60	9.59	9.65	9.68	9.81	9.59
1940	9.69	9.57	9.58	9.57	9.52	9.58	9.68	9.64				
Rapid City, S. Dak. (3,218–3,259 ft.):												
1939							6.62	6.65	6.64	6.62	6.78	6.61
1940	6.71	6.57	6.57	6.60	6.65	6.60	6.65	6.67				
Reno, Nev. (4,400–4,527 ft.):												
1939							5.49	5.48	5.48	5.54	5.59	5.54
1940	5.48	5.43	5.46	5.45	5.44	5.46	5.49	5.48				
Richmond, Va. (164–144 ft.):												
1939							9.83	9.82	9.90	9.92	0.06	9.80
1940	9.94	9.81	9.82	9.81	9.75	9.80	9.91	9.91				
Rochester, N. Y. (555–523 ft.):												
1939							9.41	9.42	9.47	9.45	9.63	9.29
1940	9.44	9.43	9.38	9.40	9.35	9.33	9.49	9.54				
Sacramento, Calif. (25–66 ft.):												
1939							9.82	9.80	9.82	9.94	0.02	0.05
1940	9.98	9.98	9.95	9.93	9.85	9.77	9.84	9.81				
St. Joseph, Mo. (817–967 ft.):												
1939							8.91	8.92	8.96	8.96	9.23	8.97
1940	9.18	8.99	8.93	8.91	8.92	8.89	8.98	8.97				
St. Louis, Mo. (564–568 ft.):												
1939							9.36	9.36	9.40	9.43	9.67	9.40
1940	9.58	9.42	9.37	9.33	9.32	9.34	9.45	9.40				
Salt Lake City, Utah (4,227–4,357 ft.):												
1935							5.57	5.58	5.62	5.64	5.71	5.72
1936	5.62	5.46	5.56	5.59	5.56	5.55	5.61	5.63	5.60	5.67	5.85	5.62
1937	5.52	5.59	5.56	5.54	5.53	5.57	5.62	5.61	5.63	5.67	5.66	5.68
1938	5.70	5.61	5.50	5.55	5.55	5.54	5.65	5.61	5.65	5.63	5.73	5.72
1939	5.64	5.59	5.62	5.60	5.53	5.54	5.61	5.62	5.64	5.66	5.77	5.72
1940	5.67	5.59	5.58	5.55	5.58	5.58	5.60	5.61				

Paths of Hurricanes and Other Tropical Storms of 1940



Station pressures at Airport adjusted to the old City Office elevation—Continued

Stations	January	February	March	April	May	June	July	August	September	October	November	December
San Antonio, Tex. (582-693 ft.):												
1939							9.22	9.22	9.25	9.32	9.49	9.34
1940	9.47	9.27	9.23	9.18	9.20	9.18	9.28	9.20				
San Diego, Calif., (28-87 ft.):												
1939							9.84	9.81	9.78	9.86	9.92	9.95
1940	9.96	9.97	9.90	9.89	9.84	9.82	9.86	9.83				
Santa Fe, N. Mex. (6,525-7,013 ft.):												
1940								3.40				
Sault Ste. Marie, Mich. (724-614 ft.):												
1939	9.27	9.30	9.36	9.24	9.28	9.26	9.30	9.28	9.34	9.27	9.52	9.16
1940	9.30	9.40	9.32	9.35	9.23	9.20	9.39	9.41				
Savannah, Ga. (51-65 ft.):												
1939							9.93	9.92	9.95	0.00	0.14	9.98
1940	0.05	9.95	9.93	9.94	9.88	9.95	0.00	9.89				
Seattle, Wash. (30-125 ft.):												
1939							9.92	9.89	9.91	9.97	9.98	9.85
1940	9.89	9.76	9.86	9.92	9.91	9.94	9.91	9.92				
Sheridan, Wyo. (3,968-3,790 ft.):												
1940				6.07	6.12	6.09	6.13	6.15				
Shreveport, La. (181-249 ft.):												
1939							9.71	9.68	9.72	9.81	9.97	9.78
1940	9.96	9.74	9.70	9.66	9.70	9.68	9.76	9.69				

Station pressures at Airport adjusted to the old City Office elevation—Continued

Stations	January	February	March	April	May	June	July	August	September	October	November	December
Sioux City, Iowa (1,103-1,138 ft.):												
1940				8.75	8.74	8.69	8.78	8.80				
Spokane, Wash. (1,968-1,929 ft.):												
1939							7.93	7.94	7.95	8.02	8.13	8.01
1940	8.07	7.89	7.93	7.95	7.96	7.94	7.92	7.95				
Springfield, Ill. (613-636 ft.):												
1939							9.29	9.29	9.33	9.34	9.58	9.30
1940	9.46	9.34	9.30	9.26	9.23	9.25	9.38	9.33				
Springfield, Mo. (1,360-1,324 ft.):												
1939							8.62	8.59	8.63	8.66	8.68	8.61
1940	8.77	8.59	8.55	8.53	8.56	8.57	8.66	8.62				
Syracuse, N. Y. (408-596 ft.):												
1939							9.32	9.33	9.38	9.36	9.53	9.19
1940	9.34	9.33	9.28	9.31	9.27	9.25	9.40	9.47				
Tampa, Fla. (11-35 ft.):												
1939							0.00	9.96	9.96	9.97	0.09	0.03
1940	0.09	0.02	9.98	9.99	9.94	0.00	0.04	9.94				
Wichita, Kans. (1,392-1,358 ft.):												
1939							8.51	8.50	8.56	8.56	8.81	8.57
1940	8.76	8.55	8.48	8.47	8.51	8.49	8.56	8.55				

NORTH ATLANTIC TROPICAL CYCLONES OF 1940

By JEAN H. GALLENNE

The hurricane season of 1940 was practically normal in all respects. There were 8 disturbances of tropical origin charted over the North Atlantic Ocean, including the Caribbean Sea and the Gulf of Mexico; 4 of these developed hurricane intensity. The average annual number of such cyclones, based on records for the past 54 years, is about 7, of which 3 or 4 usually attain full hurricane force.

There were two low barometric pressure records established, the first at the Weather Bureau office, Port Arthur, Tex., during the storm of August 2–10; the second at the Savannah, Ga., office, in connection with the hurricane of August 5–17. At Port Arthur, Tex., the lowest recorded was 977.7 millibars (28.87 inches), which is considerably lower than the low reading of 994.5 (29.37 inches) of October 16, 1923. An all-time low sea-level pressure reading of 974.7 millibars (28.78 inches) for Savannah, Ga., was noted during the afternoon of August 11.

The most destructive storm was that of August 5–15, which, after moving very slowly at sea for a period of almost a week, crossed the coast near Beaufort, S. C., during the afternoon of the 11th, accompanies by hurricane-force winds from the Savannah area nearly to Charleston. An estimated 20 persons lost their lives, and approximately $3,000,000 of property damage was sustained in the coastal areas. The storm later moved farther inland to the southern Appalachian Mountain region attended by torrential rains and disastrous floods in many sections of Georgia, Tennessee, and the Carolinas. At Weldon, N. C., on the Roanoke River, a stage of 58 feet was reached on August 18, exceeding the great flood of 1877 by about 5 feet at that place. Press reports indicate more than 30 deaths; and crop and property damage amounting to many millions of dollars resulted in these flood regions.

A synopsis of the tropical cyclones of 1940 is given in the following table. Their tracks, numbered I to VIII chronologically, are shown on the accompanying chart.

North Atlantic tropical cyclones of 1940

[Synopsis of tropical cyclones of 1940 (number of storm in table corresponds to number of track on accompanying chart)]

Storm	Date	Place where first reported	Coast lines crossed	Maximum wind velocity reported	Lowest barometer reported	Place of dissipation	Intensity	Remarks
I	May 18-27	Southeast of Turks Island.	None	Force 8, southeast, M. S. *Good Gulf.*	995.6 millibars (29.40 inches) M. S. *Lubrafol.*	Southwest of Newfoundland.	Not of hurricane intensity.	No loss of life nor property damage.
II	Aug. 2-10	Off the coast of Georgia.	Florida, Texas	Force 11, south, S. S. *Connecticut*, 82 miles northeast at Port Arthur, Tex.	977.7 millibars (28.87 inches) Port Arthur, Tex.	North-central Arkansas.	Probably of hurricane intensity.	1 person drowned, wind and rainfall damage in excess of $1,743,550.
III	Aug. 5-15	Between St. Martin and St. Thomas Islands.	South Carolina	Force 12, eastsoutheast, S. S. *Maine.*	974.7 millibars (28.78 inches) Savannah, Ga.	Southern Virginia.	Full hurricane	An estimated 50 lives lost and many millions of dollars in crops and property damage due to high winds and floods associated with this hurricane.
IV	Aug. 30-Sept. 3.	225 miles off the Florida east coast.	Nova Scotia	Force 12, east-southeast, Tanker *Franklin K. Lane.*	965.1 millibars (28.50 inches) Tanker *Franklin K. Lane.*	Quebec	Full hurricane	No loss of life, slight property damage.
V	Sept. 11-18	Northeast of St. Thomas, V. I.	Newfoundland	Force 12, north-northeast, S. S. *Borinquen.*	988.3 millibars (29.19 inches) S. S. *Borinquen.*	Newfoundland	do	No loss of life nor property damage.
VI	Sept. 19-24	Northeast of Bluefields, Nicaragua.	Honduras, Yucatan and Louisiana.	Force 8, southwest, Tanker *Dannedaike.*	1,004 millibars (29.65 inches) Tanker *Dannedaike.*	Western Alabama.	Not of hurricane intensity.	Do.
VII	Oct. 20-23	A short distance north of the Canal Zone.	Honduras	Force 9, northeast, S. S. *Contessa.*	982.7 millibars (29.02 inches) S. S. *Castilla.*	South of Puerto Cabezas.	do	Considerable property damage on the northern coast of Nicaragua.
VIII	Oct. 24-26	Greater Antilles	None	Force 7, northeast, unidentified ship.	1,008 millibars (29.77 inches). Unidentified ship.	West-central Atlantic Ocean.	do	No loss of life nor property damage.

METEOROLOGICAL AND CLIMATOLOGICAL DATA FOR DECEMBER 1940

[Climate and Crop Weather Division, J. B. KINCER in charge]

AEROLOGICAL OBSERVATIONS

By EARL C. THOM

The mean surface temperatures were above normal generally over the United States in December (chart 1). A small area in northern New York had temperatures below normal. A large part of the States of Montana and North Dakota and smaller areas in the East Central States had mean monthly temperatures 6° and 7° F. above normal.

At the 1,500-meter level the directions of the 5 a. m. (E. S. T.) resultant winds at most stations were south of normal for the month. The only station at which a considerable opposite turning from normal occurred at this level was Houston, Tex. As will be noted from chart IX none of the pilot-balloon stations along the Pacific coast, in the North Central States or in the East Central States and only one station in the northeastern section had 10 or more 5 a. m. observations during the month at the 3,000-meter level. Over the rest of the United States at this level slightly more than half of the stations had resultant winds from directions somewhat south of normal. Only one of the stations included in table 2 and located in the northern half of the country had 10 or more 5 p. m. observations which reached the 5,000-meter level during December and only 7 such cases were noted to the southward. The shifting of the resultant winds were equally divided at this level, half of the eight stations reporting 5 p. m. resultant winds from directions to the north of the corresponding 5 a. m. normals and the other half from directions south of these normals.

The 5 a. m. resultant velocities for the month were higher than normal at the 1,500-meter level over the extreme West, the Southwest, and over small areas in the North Central and Northeastern States and were lower than normal over the rest of the country. At this level the largest positive departure was at Medford, Oreg., where the resultant velocity was 2.9 meters per second above normal while the largest negative departure, 2.5 meters per second below normal, occurred at Houston, Tex. At one-half of the 12 stations, for which comparisons with normals could be made at the 3,000-meter level, the resultant velocities were above normal and at the other half these velocities were below normal. At this level a large negative departure, 5.6 meters per second below normal, was noted at Atlanta, Ga., with an almost equal opposite departure, 5.0 meters per second, above normal at Boston, Mass. At two of the eight stations where the 5 p. m. resultant velocity at 5,000 meters could be compared with the corresponding 5 a. m. normal, the afternoon resultant velocities were lower than the morning normals while at the other stations the afternoon velocities were much higher than these normals. At St. Louis, Mo., the 5 p. m. resultant velocity for the month at 5,000 meters was 12.3 meters per second higher than the corresponding morning normal.

It is noted that the above normal surface temperatures (chart 1) are well supported by the turning of resultant winds to the south of the directions of the normal resultants at the 1,500-meter level.

At the 1,500-meter level the directions of the 5 p. m. resultant winds for the month (table 2) were to the north of the corresponding 5 a. m. directions at most stations in the extreme north, the west central and the south central parts of the country and were generally south of these morning resultant directions over the rest of the country. At 3,000 meters the lack of sufficient observations prevent a similar comparison for stations situated on the Pacific coast and in the northeastern and north-central parts of the United States. Except for southern Atlantic coast stations, the directions of the 5 p. m. resultant winds at all stations in the southern one-third of the country were to the northward of the directions of the corresponding morning winds at this level. At most other stations for which this comparison could be made the

turning of the resultant winds during the day was to the southward.

The 5 p. m. resultant velocities at 1,500 meters were lower than those at 5 a. m. over most of the United States. Resultant velocities higher in the afternoon than in the morning occurred at Spokane and at stations located along the South Pacific coast and in the extreme southwest as well as in parts of the North Central States, the Great Lakes region and East Central States. A decrease in resultant velocity during the day occurred at this level over all other parts of the country. At the 3,000-meter level five stations located in a west central area and two stations at well separated locations to the eastward had resultant velocities in the afternoon lower than in the morning, while the opposite was true at all other stations for which this comparison could be made.

The upper-air data discussed above are based on 5 a. m. observations (charts VIII and IX) as well as on observations made at 5 p. m. (table 2, and charts X and XI).

In the United States proper at the 1,000-meter level the maximum mean pressure for the month, 906 millibars, (table 1) was recorded over both Miami and Pensacola, Fla. At each of the standard levels from 1,500 to 12,000 meters, inclusive, the highest mean monthly pressure occurred over Miami. At 13,000 meters a maximum pressure of 175 millibars occurred over both Brownsville and Miami while at the 14,000-meter level Brownsville and Pensacola both had a pressure of 149 millibars, the maximum for that level. At the next three higher standard levels the maximum mean monthly pressure occurred over Pensacola. At both the 1,000- and 1,500-meter levels the lowest mean pressure for December at stations within the United States was indicated at Spokane, Wash. These pressures at Spokane as well as all pressures for this station shown in table 1, are believed to be lower than the true monthly means for this station since observations were made there only during the latter half of the month when abnormally low pressures prevailed in that area. At all standard levels from 2,000 meters to 17,000 meters, inclusive, the lowest mean pressure for the month was observed over Sault Ste. Marie.

At most standard levels mean pressures observed at Alaskan stations were lower than those recorded in the United States while the mean pressures observed at Swan Island were higher at most levels.

At all stations for which airplane or radiosonde observations were made during the month (table 1) the same or lower mean pressures were recorded in December than in November at all standard levels from 1,000 meters to 10,000 meters, inclusive. The only exception was noted at the 10,000-meter level over Washington, D. C., where a mean pressure of 270 millibars was recorded in December, 1 millibar higher than the corresponding November pressure. Pressures at these levels were considerably lower in December than in November at Ketchikan, Juneau, and along the upper Pacific coast of the United States, the mean pressures at Oakland for these levels averaging 5 millibars lower than in the previous month. At higher standard levels no well-defined tendency was noted when comparing mean pressures for December with those for November.

There was a difference of 29 millibars between the highest and the lowest mean monthly pressures recorded at the 8,000 meter level over stations within the United States proper. This was the largest difference between mean pressure values recorded at any standard level. The steepest pressure gradient for the month was observed at 8,000 meters between Sault Ste. Marie and Joliet where a change of 1 millibar was recorded for each 38 miles of horizontal distance. Gradients were nearly as steep, however, from north to south over any part of the eastern third of the country, the difference in mean pressures at Sault Ste. Marie and Charleston being 24 millibars, or about 1 millibar for each 42 miles.

At the 1,000-, 2,000-, and 3,000-meter levels mean temperatures in December were lower than in November at most stations on the Atlantic coast and at those in the Southwest, the south central and the west central parts of the country. Mean temperatures were higher than in the previous month at these levels in Alaska and over the extreme northwest and north central parts of the country. Corresponding temperature departures were not well defined at these levels over the remainder of the country. At most standard levels from 5,000 meters to 11,000 meters, stations located in Alaska and in the extreme north central states had mean temperatures higher than those of the previous month. Corresponding tendencies were not well defined at these levels for Seattle, Omaha, or Joliet while at all other United States stations lower mean temperatures than last month were observed at these levels. With few exceptions mean temperatures at levels from 13,000 meters to 19,000 meters were higher than corresponding temperatures for November.

Mean temperatures for December this year were generally higher than those for December of last year over the eastern half of the United States and were generally lower to the westward at the standard levels above the surface up to and including 2,000 meters. The principal exception to this occurred over the Great Lakes where temperatures at these levels were lower than last year, and at Spokane where temperatures were higher than last year. At most of the standard levels from 2,500 meters to 6,000 meters mean temperatures for the month were higher than last year over that part of the eastern half of the country which lies above the Gulf Coast and were lower than last year over the Gulf Coast and over the western half of the country. At higher levels no well defined tendency was observed when the mean temperatures for the month were compared with those of last year.

The mean surface temperature for the month of December as recorded by radiosonde observations (table 1) was 0° C. or lower at all stations located in the extreme northeast, the Great Lakes region, the North Central States and the northern Rocky Mountain plateau. At three stations in this area, however, temperature inversions recorded during the month resulted in mean temperatures above freezing for the lower levels above the surface and in a level having a mean temperature of 0° C. above the inversion. Over the rest of the United States the altitude at which a mean temperature of 0° C. was observed during December varied from 4,000 meters (m. s. l.) over Miami, Fla., to 1,400 meters over Lakehurst, N. J. The level of mean freezing temperature was 2,700 meters or higher at all stations south of 36° N. latitude. At two stations (Seattle, Wash., and Washington, D. C.) the level of mean freezing temperature was slightly higher than in November, while at all other stations it was lower than in the previous month.

The extreme minimum temperature for the month recorded by radiosondes in the free air was −92.6° C. (−134.5° F.) observed over Swan Island on December 28 at a height of 17,800 meters (m. s. l.). The lowest temperature recorded over United States was −84.5° C. (−120.1° F.) recorded over Miami, Fla., on December 1, 1940, at 15,000 meters and again on the next day at 16,200 meters. Seven stations in the United States

reported the lowest observed temperature during the month as higher than −70° C.

Table 3 shows the maximum free-air wind velocities and their directions for various sections of the United States during December as determined by pilot-balloon observations. The highest wind velocity reported for the month was 92.2 meters per second (206 miles per hour) observed over Casper, Wyo., on December 28. This high wind was from the northwest at an elevation of 8,910 meters (about 5.5 miles) above sea level. The maximum winds reported in December this year at all levels were the highest reported in this month during the last 4 years.

Tropopause data for December showing the mean altitude and temperature of the tropopause at various stations are shown in table 4 and on chart XIII.

MEAN ISENTROPIC CHART [1]

The monthly chart for December as a whole is typical of the winter season with strong westerlies north of latitude 35°, and both sets of isobars tending to run parallel to latitude lines. Normal data for this surface are not available, but the mean moisture content over California appears to be quite high.

December 1940 was characterized by widely different types of weather, as can be seen by a study of the weekly climatological bulletins. It is therefore not surprising that the mean monthly isentropic chart reflects no typical correlation with the weather of the month.

[1] Prepared by A. K. Showalter, Hydrometeorological Section.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent obtained by airplanes and radiosondes during December 1940*

Stations with elevations in meters above sea level

Altitude (meters) m. s. l.	Anchorage Alaska (41 m.)				Atlantic Station No. 1 [3] (3 m.)				Atlantic Station No. 2 [4] (3 m.)				Barrow, Alaska (6 m.)				Bethel, Alaska (7 m.)				Bismark, N. Dak. (505 m.)				Brownsville, Tex. (6 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	993	−5.3	85	26	1,019	15.3	74	15	1,017	14.3	81	27	1,011	−20.8	83	17	998	−10.8	88	31	956	−7.2	87	31	1,016	16.4	89
500	31	938	−2.9	82	26	960	11.0	78	15	958	10.0	83	27	946	−20.6	87	17	937	−6.2	88					31	959	16.0	83
1,000	31	880	−3.3	76	26	904	7.2	82	15	902	6.2	87	27	884	−17.5	82	17	879	−5.9	85	31	898	−2.3	75	31	904	14.2	75
1,500	31	825	−6.0	74	26	851	4.9	79	15	848	3.6	83	27	827	−17.5	79	17	824	−7.6	80	31	843	−2.3	69	31	852	12.2	70
2,000	31	774	−8.9	74	26	800	3.2	70	15	798	2.4	69	27	773	−18.7	78	17	773	−10.7	77	31	791	−3.5	65	31	803	10.2	64
2,500	31	725	−12.0	73	26	752	1.7	56	14	750	.7	60	27	722	−20.4	76	17	724	−13.9	75	31	743	−5.6	63	31	756	7.9	61
3,000	31	679	−15.0	70	26	707	−.2	50	14	704	−2.1	56	27	675	−22.7	72	17	677	−17.1	73	31	697	−8.3	62	31	711	5.4	55
4,000	31	594	−21.4	67	25	623	−5.9	46	14	620	−8.2	51	27	588	−28.4	68	17	592	−24.5	71	31	612	−14.2	61	30	628	−.6	51
5,000	30	518	−28.1	66	24	547	−12.2	46	14	544	−14.6	47	27	510	−34.8	65	17	515	−31.4	63	31	535	−20.6	60	29	554	−7.4	48
6,000	30	450	−35.0	65	23	479	−19.0	48	14	476	−21.8	46	27	442	−41.0	62	16	446	−38.5	57	31	467	−27.7	58	29	486	−14.2	45
7,000	29	380	−42.0		21	418	−25.8	50	14	414	−28.9	44	27	381	−47.0		16	384	−45.5		31	405	−34.6	56	29	425	−21.2	45
8,000	29	335	−48.4		19	363	−32.9	51	14	360	−36.1	44	27	326	−52.0		16	330	−51.8		31	350	−41.9		29	371	−28.0	43
9,000	29	287	−53.6		17	314	−39.9		13	311	−42.5		27	279	−55.3		15	283	−55.8		31	302	−48.6		29	322	−34.9	41
10,000	28	246	−55.4		16	271	−47.3		13	268	−48.0		26	239	−56.6		15	242	−55.8		31	258	−53.5		29	278	−42.4	
11,000	27	210	−54.8		17	232	−53.3		12	230	−52.4		26	204	−55.3		14	207	−53.7		31	222	−55.3		28	240	−48.8	
12,000	27	180	−52.9		15	198	−57.6		11	196	−55.6		26	174	−54.6		13	177	−52.2		31	189	−54.6		28	205	−54.2	
13,000	26	154	−51.7		14	169	−60.4		10	167	−57.7		24	149	−54.7		13	151	−51.5		30	162	−54.8		25	175	−59.2	
14,000	24	132	−51.8		12	144	−61.5		9	142	−61.8		24	127	−55.2		12	130	−51.4		26	138	−55.7		24	149	−64.9	
15,000	21	113	−52.1		10	122	−64.5		7	120	−64.0		22	109	−55.7		8	111	−51.1		25	118	−56.7		24	126	−68.5	
16,000	19	97	−52.4		10	104	−66.1		6	102	−66.4		19	93	−56.5		5	95	−50.1		22	101	−57.6		22	107	−71.6	
17,000	14	83	−52.8		10	88	−66.4		6	85	−66.6		12	79	−58.1						12	86	−59.1		21	90	−70.9	
18,000	9	71	−53.4		8	74	−65.8		5	72	−66.0		9	67	−59.1						5	73	−60.7		19	77	−67.4	
19,000																									14	65	−64.0	

Stations with elevations in meters above sea level

Altitude (meters) m. s. l.	Charleston, S. C. (14 m.)				Coco Solo, C. Z. [1] [3] (15 m.)				Denver, Colo. (1,616 m.)				El Paso, Tex. (1,193 m.)				Ely, Nev. (1,908 m.)				Fairbanks, Alaska (153 m.)				Great Falls, Mont. (1,122 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	1,018	9.5	89	23	1,012	26.3	89	31	837	−2.5	78	31	884	7.6	61	31	809	−3.7	76	31	985	−16.6	77	28	884	−0.4	61
500	30	960	11.4	80	23	956	23.7	89													31	942	−11.4	82				
1,000	30	905	9.7	75	23	903	20.9	79													31	883	−10.0	80				
1,500	30	852	8.0	67	23	852	18.0	73					31	852	9.8	55					31	827	−9.9	78	28	844	.3	60
2,000	30	801	6.6	61	23	804	15.8	57	31	798	1.7	69	31	802	7.4	52	31	800	−1.8	74	31	776	−11.3	75	28	793	−1.9	58
2,500	30	754	4.1	60	23	757	13.3	43	31	750	−.4	63	31	754	5.0	49	31	751	−1.2	66	31	726	−13.7	69	28	744	−5.1	59
3,000	30	708	1.7	52	23	713	10.8	33	31	704	−3.3	60	31	709	2.0	48	31	705	−3.7	65	31	679	−16.4	68	28	698	−8.1	59
4,000	30	625	−2.9	43	20	632	4.4	31	31	619	−9.4	59	31	625	−4.4	45	31	621	−8.8	57	29	594	−22.8	67	28	613	−14.3	56
5,000	31	551	−9.5	43					31	544	−15.9	57	31	550	−11.1	44	31	545	−15.4	53	29	518	−29.3	64	28	536	−20.6	53
6,000	31	483	−16.2	44					30	475	−22.8	55	31	482	−17.7	43	30	476	−22.5	52	27	449	−35.9	62	28	468	−27.5	51
7,000	31	422	−22.9	44					30	413	−30.1	54	30	421	−25.1	41	30	415	−30.3	51	26	388	−43.0		28	406	−35.0	50
8,000	31	368	−30.0	44					29	358	−37.8	54	30	366	−33.1	38	30	360	−37.6	51	23	333	−49.1		28	351	−42.3	
9,000	31	318	−37.7	44					29	309	−45.7		30	317	−40.8		30	310	−43.9		21	285	−53.1		28	302	−48.9	
10,000	31	275	−45.4						28	265	−52.2		29	273	−47.7		29	267	−49.8		18	244	−53.7		27	259	−54.1	
11,000	31	236	−52.7						26	228	−55.6		28	234	−53.3		29	229	−54.4		16	209	−52.5		26	222	−55.9	
12,000	30	202	−57.6						25	194	−56.8		25	200	−56.6		28	196	−56.2		16	179	−51.9		25	190	−55.2	
13,000	30	172	−61.6						25	166	−57.7		25	171	−59.8		27	167	−57.6		13	153	−51.3		25	162	−54.5	
14,000	28	147	−63.4						24	141	−59.3		25	145	−62.8		25	142	−59.3		12	131	−51.2		25	139	−55.3	
15,000	27	124	−66.6						22	120	−60.8		23	123	−66.1		25	121	−61.7		9	112	−51.8		24	119	−56.8	
16,000	25	105	−68.4						17	102	−62.4		23	105	−67.6		23	103	−63.2		7	96	−52.6		21	102	−58.1	
17,000	24	89	−69.1						13	87	−62.3		23	88	−66.5		20	88	−63.0						20	87	−58.3	
18,000	20	75	−68.5						5	74	−61.9		21	75	−64.6		5	74	−60.6						14	74	−58.3	
19,000	13	63	−67.5										12	64	−62.2										6	63	−59.2	
20,000	8	53	−65.3																									

See footnotes at end of table.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during December 1940*—Continued

Stations with elevations in meters above sea level

Altitude (meters) m. s. l.	Joliet, Ill. (178 m.)				Juneau, Alaska (49 m.)				Ketchikan, Alaska (26 m.)				Lakehurst, N. J.[1] (39 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	997	−0.7	90	31	998	2.1	83	21	1,005	3.1	84	30	1,015	1.6	80
500	30	958	−1.6	88	31	944	.2	81	21	947	1.9	83	30	959	1.4	78
1,000	30	900	−.8	78	30	887	−2.3	82	21	890	−.3	80	30	901	.7	72
1,500	30	845	−.8	72	29	832	−4.9	83	21	836	−2.5	73	30	846	−.2	64
2,000	30	793	−2.0	67	27	780	−7.3	81	21	785	−5.2	69	30	795	−1.6	59
2,500	30	745	−3.8	64	24	732	−9.9	78	21	736	−8.2	67	30	746	−3.1	53
3,000	30	699	−6.1	64	22	686	−12.8	72	21	690	−11.5	66	30	700	−5.7	52
4,000	30	614	−11.4	58	21	600	−19.2	65	21	604	−18.0	62	29	615	−10.5	49
5,000	31	539	−17.7	56	20	524	−26.1	60	21	528	−24.7	60	29	539	−16.6	51
6,000	31	470	−24.6	54	16	455	−33.2		21	460	−31.5	57	29	471	−23.6	52
7,000	31	409	−31.7	54	14	394	−39.9		21	398	−37.8	54	29	410	−30.7	53
8,000	31	354	−39.2	54	14	339	−45.1		21	343	−44.3		29	356	−37.4	
9,000	31	305	−46.6		13	292	−47.7		20	295	−50.1		29	307	−44.3	
10,000	29	262	−53.4		13	250	−48.6		20	253	−53.4		26	264	−50.1	
11,000	28	224	−57.4		13	215	−48.0		20	217	−54.9		25	226	−55.2	
12,000	26	191	−57.7		13	185	−47.6		19	185	−54.8		23	193	−58.1	
13,000	23	163	−58.2		11	159	−46.7		18	158	−53.5		20	164	−59.1	
14,000	23	138	−59.3		9	137	−46.6		16	136	−52.7		18	140	−59.9	
15,000	23	118	−60.7		7	118	−47.0		14	116	−51.9		17	119	−61.0	
16,000	22	100	−61.4						13	99	−52.2		14	101	−62.1	
17,000	18	85	−61.6						10	85	−52.2		8	85	−62.8	
18,000	12	72	−61.3						6	73	−52.8					
19,000																
20,000																
21,000																

Altitude (meters) m. s. l.	Medford, Oreg. (401 m.				Miami, Fla. (4 m.)				Nashville, Tenn. (180 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	966	4.7	83	31	1,017	19.6	88	31	998	6.2	85
500	31	954	4.9	83	31	960	18.1	86	31	960	6.4	83
1,000	31	898	4.7	76	31	906	15.0	81	31	903	5.5	78
1,500	31	844	3.7	66	31	854	11.8	79	31	849	5.1	71
2,000	31	793	1.4	65	31	804	9.9	66	31	798	3.2	65
2,500	31	745	−.9	60	31	757	7.7	55	31	751	1.2	59
3,000	31	700	−3.2	54	31	712	5.4	48	31	705	−1.2	56
4,000	30	616	−9.3	51	30	630	.2	40	31	621	−6.7	52
5,000	30	541	−15.9	49	30	555	−6.0	34	31	546	−12.7	48
6,000	30	472	−23.1	48	30	488	−12.7	33	31	478	−19.5	48
7,000	30	411	−30.1	48	30	427	−19.9	34	31	417	−26.7	47
8,000	30	356	−38.1	47	30	373	−26.8	34	31	362	−34.5	46
9,000	28	307	−45.7		30	324	−34.4	34	31	313	−42.7	
10,000	28	264	−52.2		30	280	−42.4		30	269	−50.3	
11,000	28	226	−56.0		29	241	−49.9		29	231	−55.8	
12,000	28	193	−56.9		27	206	−56.8		29	197	−58.9	
13,000	27	165	−57.8		27	175	−62.9		29	168	−60.7	
14,000	27	140	−58.5		27	148	−67.2		29	143	−62.5	
15,000	27	120	−59.6		27	125	−72.4		28	122	−64.5	
16,000	26	102	−60.7		25	106	−75.4		27	103	−66.4	
17,000	22	87	−61.1		23	89	−74.5		23	88	−66.3	
18,000	22	74	−60.6		20	75	−70.2		18	74	−65.6	
19,000	15	63	−60.3		16	63	−64.8		10	63	−65.0	
20,000	6	53	−60.4		11	54	−60.9					
21,000					6	46	−59.3					

Stations with elevations in meters above sea level

Altitude (meters) m. s. l.	Nome, Alaska (14 m.)				Norfolk, Va.[1, 2] (10 m.)				Oakland, Calif. (2 m.)				Oklahoma City, Okla. (391 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	1,002	−11.9	78	20	1,022	5.7	74	31	1,014	10.4	81	31	973	3.2	87
500	31	941	−12.0	80	20	961	5.0	65	31	955	11.4	70	31	960	4.6	83
1,000	31	881	−12.3	81	20	904	3.4	59	31	900	9.7	65	31	903	5.4	65
1,500	31	825	−12.8	79	20	850	2.9	52	30	847	7.5	61	31	850	5.4	55
2,000	31	773	−14.7	75	20	799	1.8	46	30	797	5.0	57	31	799	4.6	49
2,500	31	723	−17.2	73	20	751	−.2	38	30	749	2.4	55	31	751	2.4	46
3,000	31	676	−20.0	72	20	705	−2.8	33	30	704	−.7	53	31	706	−.2	45
4,000	30	590	−26.3	67	20	621	−8.0	30	30	620	−7.0	52	31	622	−5.9	43
5,000	30	513	−32.8	63	16	545	−14.3	28	30	545	−14.0	50	31	547	−12.3	39
6,000	30	444	−39.5	61					30	477	−20.9	50	31	479	−19.9	37
7,000	29	383	−46.0						30	415	−28.0	49	30	418	−27.4	38
8,000	28	329	−51.6						30	361	−35.4	48	29	363	−35.4	37
9,000	27	282	−55.2						29	311	−42.6		27	313	−43.8	
10,000	27	241	−54.9						29	268	−49.7		26	269	−51.7	
11,000	27	207	−53.3						28	230	−54.7		25	230	−57.3	
12,000	27	177	−52.5						27	196	−56.5		22	197	−59.8	
13,000	27	152	−52.2						27	167	−58.3		22	167	−61.8	
14,000	25	130	−52.1						27	142	−59.6		20	142	−63.6	
15,000	23	112	−52.4						24	121	−62.0		17	120	−66.7	
16,000	14	96	−52.7						24	102	−63.8		15	102	−67.5	
17,000									17	87	−64.0		13	87	−66.7	
18,000									12	74	−62.6		10	74	−66.5	
19,000									7	63	−62.6		6	62	−66.3	

Altitude (meters) m. s. l.	Omaha, Nebr. (301 m.)				Pearl Harbor, T. H. (6 m.)[1, 3]				Pensacola, Fla.[1, 3] (24 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	983	−1.7	83	31	1,014	20.3	86	29	1,017	13.6	80
500	31	959	−1.2	80	31	958	19.9	79	29	961	12.9	77
1,000	31	902	.7	68	31	904	17.2	81	29	906	11.7	71
1,500	31	847	.4	64	31	858	15.1	73	29	853	9.7	66
2,000	31	795	−.8	60	31	803	13.6	53	29	803	7.7	59
2,500	31	747	−3.1	58	31	757	12.8	30	29	756	5.3	54
3,000	31	701	−5.3	56	31	713	11.3	19	29	710	2.7	48
4,000	31	617	−10.4	57	31	632	6.4	13	27	627	−3.2	51
5,000	30	541	−16.6	58	5	560	1.3	10	23	552	−9.6	51
6,000	30	473	−23.5	57					22	484	−16.5	54
7,000	30	411	−30.6	56					22	424	−23.6	54
8,000	29	356	−38.3	54					22	368	−31.0	57
9,000	29	307	−45.7						20	319	−38.5	61
10,000	28	264	−52.0						18	276	−45.4	
11,000	24	226	−55.0						14	237	−50.8	
12,000	22	193	−55.4						13	204	−54.1	
13,000	20	165	−56.3						11	174	−57.7	
14,000	19	141	−57.7						9	149	−60.7	
15,000	18	120	−59.8						7	127	−63.4	
16,000	15	103	−60.8						5	108	−66.7	
17,000	12	87	−60.0						5	92	−67.7	
18,000	5	74	−60.3									
19,000												

See footnotes at end of table.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees Centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during December 1940*—Continued

Stations with elevations in meters above sea level

Altitude (meters) m.s.l.	Phoenix, Ariz. (339 m.)				Portland, Maine (9 m.)				St. Thomas, V. I.[1] (8 m.)				San Diego, Calif.[1] (19 m.)				S. S. Marie, Mich. (221 m.)				Seattle, Wash.[1] (27 m.)				Spokane, Wash. (598 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	976	11.0	76	31	1,016	−5.2	88					29	1,012	14.5	82	31	990	−5.8	87	31	1,010	6.8	82	15	938	2.0	91
500	31	958	14.0	67	31	956	−2.3	86					29	956	15.7	58	31	955	−6.9	92	21	954	5.9	75				
1,000	31	903	13.3	56	31	898	−2.8	82					29	902	13.5	49	31	896	−8.2	90	31	897	3.6	72	15	893	2.9	88
1,500	31	850	10.6	51	31	843	−3.4	79					29	849	10.6	45	30	840	−8.3	82	31	843	.8	71	14	839	1.6	84
2,000	31	800	7.7	49	31	791	−4.7	77					29	800	7.8	42	30	787	−9.0	76	31	792	−1.8	68	14	788	−1.6	86
2,500	31	753	4.9	47	31	742	−6.2	74					29	752	5.0	40	30	738	−10.5	73	31	743	−4.7	63	14	789	−4.6	88
3,000	30	708	2.3	45	31	696	−8.4	72					28	707	2.3	39	30	691	−12.4	71	31	697	−7.5	59	14	694	−7.7	86
4,000	30	625	−4.0	41	31	611	−13.5	70					28	624	−4.1	44	30	605	−17.4	70	30	612	−13.3	57	12	609	−13.1	77
5,000	30	550	−11.0	39	31	535	−19.1	69					28	549	−11.0	52	30	529	−23.8	67	30	536	−19.8	55	11	533	−19.9	72
6,000	30	482	−18.2	38	31	467	−25.8	68					28	481	−18.0	55	29	460	−30.6	65	30	467	−26.9	57	10	466	−26.9	69
7,000	30	420	−25.2	38	31	406	−33.0	68					28	421	−25.3	59	28	399	−37.3	64	30	406	−34.2	61	8	404	−34.5	66
8,000	30	366	−32.6	38	30	351	−40.3						28	366	−32.3		27	344	−43.8		30	352	−41.6		8	350	−41.7	
9,000	28	317	−40.1		29	303	−47.2						27	316	−39.5		26	296	−50.0		30	303	−47.9		8	301	−49.1	
10,000	26	273	−46.7		28	260	−52.7						26	273	−46.1		25	254	−55.6		30	260	−52.6		8	258	−54.1	
11,000	24	234	−52.4		27	223	−55.7						24	234	−52.3		23	217	−56.9		29	223	−55.8		8	221	−54.9	
12,000	22	200	−56.4		24	190	−56.1						22	200	−55.8		22	185	−56.1		29	191	−55.8		8	189	−54.9	
13,000	20	171	−59.0		22	163	−56.3						16	171	−59.2		21	158	−56.0		28	163	−54.7		8	161	−54.2	
14,000	20	145	−62.6		21	139	−57.6						15	146	−62.3		20	135	−57.0		27	139	−54.9		8	138	−55.0	
15,000	20	122	−65.9		20	119	−59.0						11	124	−65.7		20	116	−58.3		27	119	−55.5		7	118	−56.3	
16,000	18	104	−68.9		17	101	−59.6						9	105	−67.9		15	99	−58.6		25	102	−56.3		7	101	−57.5	
17,000	13	88	−68.3		15	87	−60.6						6	89	−69.7		10	84	−60.0		21	87	−56.7					
18,000	10	74	−66.0		13	74	−60.9										6	72	−61.1		13	74	−56.8					
19,000	9	62	−63.9		8	63	−61.1														9	62	−56.8					

Stations with elevations in meters above sea level

Altitude (meters) m.s.l.	Swan Island, West Indies (10 m.)				Washington, D. C.[1] (7 m.)				Late reports for—October 1940 Barrow, Alaska (6 m.)				November 1940 Barrow, Alaska (6 m.)				November 1940 Bethel, Alaska (7 m.)				November 1940 Atlantic Station No. 1[3] (3 m.)				November 1940 Atlantic Station No. 2[4] (3 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	31	1,012	25.6	80	30	1,019	4.0	78	30	1,012	−4.2	92	30	1,014	−11.9	86	28	1,008	−4.4	90	22	1,020	17.4	70	18	1,021	17.1	73
500	31	957	22.8	82	30	960	3.8	75	30	950	−6.8	91	30	951	−9.2	70	28	947	−2.9	87	22	961	12.8	76	18	962	13.0	76
1,000	31	904	20.0	82	30	903	3.2	72	30	891	−9.2	91	30	891	−9.3	71	28	889	−4.7	86	22	906	8.8	81	18	907	9.2	78
1,500	31	853	17.1	79	30	849	2.8	67	30	835	−10.5	84	30	835	−11.2	66	28	834	−7.0	79	22	852	5.5	80	18	853	5.4	80
2,000	31	804	14.6	73	30	797	1.5	62	30	782	−12.0	76	30	782	−13.2	59	28	782	−8.7	66	22	802	3.4	76	18	803	4.3	70
2,500	31	758	12.5	63	30	749	−1.0	59	30	732	−14.0	71	30	732	−15.7	55	27	732	−11.4	62	21	754	2.2	67	18	755	2.4	55
3,000	31	714	9.8	57	30	703	−3.1	54	30	685	−16.6	69	30	685	−18.4	53	27	686	−14.4	62	20	708	0	59	16	709	.4	48
4,000	30	632	4.7	43	30	619	−8.6	53	29	599	−22.3	65	30	598	−24.4	51	27	600	−20.9	61	19	624	−4.9	53	14	625	−5.3	43
5,000	30	559	−1.1	35	29	543	−14.5	52	29	522	−29.0	63	30	520	−30.4	50	27	523	−27.8	60	11	549	−10.7	47	13	550	−10.9	39
6,000	30	492	−7.7	36	28	475	−21.2	55	29	453	−36.2	60	30	451	−37.3	48	26	454	−34.7	62	9	481	−18.0	44	11	481	−18.2	40
7,000	30	432	−14.2	34	28	414	−27.8	55	29	391	−43.2		29	390	−44.0		26	393	−41.7		7	420	−24.4		10	419	−26.2	41
8,000	30	378	−20.8	35	16	360	−34.1	53	27	336	−49.7		29	335	−50.4		25	338	−47.5						10	364	−33.4	40
9,000	30	329	−28.3	34	16	311	−41.2		26	288	−54.1		29	287	−55.0		25	290	−51.2						7	314	−41.2	
10,000	30	286	−36.3		14	270	−47.8		26	247	−53.8		29	245	−56.3		25	249	−54.0						6	269	−48.9	
11,000	30	247	−44.2		8	233	−53.2		26	212	−51.5		29	210	−56.4		23	213	−53.4									
12,000	30	212	−51.9						26	181	−50.4		29	179	−54.5		22	182	−52.9									
13,000	30	182	−58.9						23	155	−50.0		27	153	−53.0		20	156	−51.7									
14,000	29	154	−65.3						23	133	−50.1		27	131	−52.5		16	133	−51.3									
15,000	29	131	−71.6						21	115	−50.0		27	112	−52.2		12	114	−50.5									
16,000	29	110	−77.0						16	98	−50.0		23	96	−52.0		10	97	−50.1									
17,000	26	92	−80.9						14	84	−50.4		15	82	−52.2		7	83	−50.1									
18,000	22	77	−80.8						12	72	−50.7		10	71	−52.3		6	70	−49.9									
19,000	19	65	−75.3						8	62	−51.2		6	60	−52.5													
20,000	14	55	−68.5																									
21,000	9	46	−64.9																									

[1] U. S. Navy.
[2] Airplane observations.
[3] Observations made on Coast Guard Vessels in or near the 5° square:
Lat. 35°00′ N. to 40°00′ N.
Long. 55°00′ W. to 60°00′ W.
[4] Observations made on Coast Guard Vessels in or near the 5° square;
Lat. 35°00′ N. to 40°00′ N.
Long. 45°00′ W. to 50°00′ W.
[5] Radiosonde and airplane observations.

NOTE.—All observations taken at 12:30 a. m., 75th meridian time, except at Washington, D. C., and Lakehurst, N. J., where they are taken near 5 a. m., E. S. T., at Norfolk, Va., where they are taken at about 6 a. m., and at Pearl Harbor, T. H., shortly after sunrise.

None of the means included in this table are based on less than 15 surface or 5 standard level observations.

Number of observations refers to pressure only as temperature and humidity data are missing for some observations at certain levels; also, the humidity data are not used in daily observations when the temperature is below −40° C.

TABLE 2.—*Free-air resultant winds based on pilot balloon observations made near 5 p. m. (75th meridian time) during December 1940. Directions given in degrees from North (N=360°, E=90°, S=180°, W=270°)—Velocities in meters per second*

Altitude (meters) m. s. l.	Abilene, Tex. (537 m.)			Albuquerque, N. Mex (1,630 m.)			Atlanta, Ga. (299 m.)			Billings, Mont. (1,095 m.)			Bismarck, N. Dak. (512 m.)			Boise, Idaho (870 m.)			Brownsville, Tex. (7 m.)			Buffalo, N. Y. (220 m.)			Burlington Vt. (132 m.)			Charleston, S.C. (18 m.)			Chicago, Ill. (192 m.)			Cincinnati, Ohio (157 m.)			Denver, Colo. (1,627 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	27	236	1.6	31	340	1.1	27	324	0.6	30	252	4.6	27	291	1.9	31	125	1.4	26	136	0.8	28	251	2.8	27	176	1.8	26	192	0.7	23	265	1.8	30	244	1.1	31	352	0.9
500							27	324	0.3										26	132	1.6	28	247	6.0	27	221	4.1	26	209	2.1	23	244	3.8	30	232	2.8			
1,000	26	254	2.0				25	256	1.7				26	276	5.9	31	117	2.3	19	71	0.5	22	252	9.1	22	268	7.3	25	238	3.9	15	249	8.3	24	229	5.9			
1,500	25	268	2.9				23	254	4.5	30	260	7.6	24	289	8.1	31	169	2.9	16	281	2.1	18	259	10.3	18	291	9.6	25	238	6.3	12	273	10.4	21	246	9.5			
2,000	24	267	4.8	31	295	1.3	22	271	4.8	30	271	7.8	21	282	9.1	31	222	3.8	10	250	2.7	16	264	9.9	13	297	13.6	24	243	6.4	11	279	12.9	18	248	10.7	31	260	.8
2,500	23	273	6.7	29	282	4.1	17	279	6.8	30	285	8.6	21	287	10.6	30	249	6.0	10	258	4.8	14	272	13.5	11	299	16.8	21	254	5.7	11	273	15.1	16	260	11.6	29	284	3.7
3,000	23	277	7.9	27	293	6.6	15	283	9.1	28	288	9.3	20	279	10.2	28	262	7.1				11	277	15.9				19	255	9.4	11	275	17.2	12	267	14.2	29	289	5.4
4,000	22	288	10.4	23	294	9.2	15	274	11.5	25	285	12.1	17	283	10.9	22	271	8.7										17	257	11.4							28	295	10.6
5,000	21	292	10.5	21	286	9.5	15	280	13.9	22	287	15.2	16	298	11.7	18	288	10.8																			26	298	13.3
6,000	19	294	11.9	20	296	12.2	12	271	14.0	19	303	15.8	14	301	14.2	15	295	10.1																			24	298	15.0
8,000	14	308	13.2	18	313	14.9	10	271	19.6	12	323	12.5	11	291	9.6																						19	292	21.1
10,000	11	306	13.1	16	292	18.5																															11	292	21.4
12,000	10	304	13.9	13	289	21.2																																	

Altitude (meters) m. s. l.	El Paso, Tex. (1,196 m.)			Ely, Nev. (1,910 m.)			Grand Junction, Colo. (1,413 m.)			Greensboro, N. C. (271 m.)			Havre, Mont. (766 m.)			Jacksonville, Fla. (14 m.)			Las Vegas, Nev. (570 m.)			Little Rock, Ark. (79 m.)			Medford, Oreg. (410 m.)			Miami, Fla. (10 m.)			Minneapolis, Minn. (261 m.)			Mobile, Ala. (10 m.)			Nashville, Tenn. (194 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	31	261	2.1	31	167	2.0	26	250	0.2	25	266	1.1	31	258	1.8	26	71	1.2	31	74	1.9	29	99	0.2	22	128	2.6	30	87	1.5	28	264	1.4	30	60	1.4	26	198	1.2
500										25	241	2.0				26	136	2.6				29	274	0.7	22	136	2.9	30	95	2.4	28	263	2.9	29	90	2.0	26	189	1.8
1,000										25	249	3.7	31	253	5.7	24	188	3.5	31	62	2.7	26	255	2.9	21	160	4.6	30	117	1.9	20	266	4.6	25	105	.9	22	237	4.2
1,500	31	249	2.5				26	276	.1	25	268	5.8	31	260	10.0	22	232	4.2	30	62	1.8	24	292	4.9	21	184	5.0	28	172	1.5	19	280	7.2	22	272	2.2	20	259	6.3
2,000	31	269	3.7	31	169	2.4	26	292	.6	23	270	7.7	31	266	10.7	21	244	5.6	26	228	1.4	23	297	5.6	21	206	7.3	26	214	2.7	17	285	9.8	21	284	3.8	19	262	7.3
2,500	30	276	5.7	30	206	2.9	24	229	2.3	23	272	9.0	29	274	10.2	21	251	6.8	25	248	2.0	20	205	7.4	14	234	7.6	26	215	3.3	15	282	12.3	20	291	6.0	19	266	10.2
3,000	29	272	6.5	28	245	2.9	22	243	4.9	23	275	11.1	29	271	11.0	20	262	7.6	23	283	3.3	18	292	10.3	10	294	3.5	27	222	4.8	11	281	12.1	18	288	8.2	18	269	11.9
4,000	26	275	7.5	22	279	6.9	20	275	7.7	20	268	14.2	22	274	9.4	16	269	8.9	23	276	6.9	17	287	14.2				26	216	6.0				14	296	10.3	15	285	13.4
5,000	25	267	9.5	21	281	9.8	18	284	11.3	16	270	18.2	21	270	8.9	17	257	12.8	21	278	8.8	12	286	13.5				24	238	8.1				11	269	9.9	11	294	17.0
6,000	22	285	10.1	21	281	10.7	15	294	15.5	15	268	19.0	16	283	8.1	17	263	14.0	19	272	10.6	10	276	13.3				19	242	9.1									
8,000	10	296	12.3	16	289	13.5				12	272	23.8	10	319	7.9	12	272	16.4	15	285	19.2							18	250	15.5									
10,000				13	295	17.9				10	276	31.7							12	292	16.5							14	257	20.2									
12,000				11	274	24.9													10	276	16.3							10	255	24.4									
14,000																																							

Altitude (meters) m. s. l.	New York, N. Y. (15 m.)			Oakland, Calif. (8 m.)			Oklahoma City, Okla. (402 m.)			Omaha, Nebr. (306 m.)			Phoenix, Ariz. (344 m.)			Rapid City, S. Dak. (982 m.)			St. Louis, Mo. (181 m.)			San Antonio, Tex. (183 m.)			San Diego, Calif. (15 m.)			Sault St. Marie, Mich. (230 m.)			Seattle, Wash. (14 m.)			Spokane, Wash. (603 m.)			Washington, D. C. (10 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	29	298	2.9	28	191	1.3	25	201	1.3	30	344	0.7	30	27	0.3	29	306	1.7	26	254	0.8	29	38	1.0	28	281	2.8	19	260	0.1	25	164	1.7	25	191	1.2	27	270	1.3
500	28	275	4.9	28	134	2.0	25	187	1.3	30	316	1.2	30	39	1.0				25	228	2.3	29	52	1.0	28	269	1.9	19	237	2.4	25	186	3.6				27	265	4.7
1,000	24	282	8.1	27	192	3.0	24	210	4.2	28	279	4.1	30	132	1.1	29	302	1.9	19	242	5.8	26	90	0.5	27	215	.8	14	278	5.4	22	190	4.8	25	186	3.2	27	267	6.8
1,500	17	305	9.2	25	210	3.9	22	251	3.5	26	276	5.6	29	184	2.2	29	299	6.1	16	269	9.4	23	220	0.8	25	146	.5				21	195	4.8	22	210	5.8	25	284	7.4
2,000	11	298	11.0	22	235	3.9	22	266	5.2	23	267	8.2	28	196	2.5	29	297	8.2	16	281	10.8	18	301	3.9	25	258	1.3				17	200	3.5	21	222	5.4	19	292	9.7
2,500				20	246	4.2	22	280	6.9	21	272	10.1	25	248	2.1	28	299	10.8	16	283	11.6	17	298	5.5	21	248	1.5				16	225	4.5	17	244	6.0	17	279	13.1
3,000				19	246	5.6	22	274	9.0	19	277	12.3	25	267	3.8	27	300	10.6	16	278	12.9	17	302	6.2	20	267	4.2				14	264	3.4	14	252	7.1	16	279	15.1
4,000				17	265	6.9	19	274	10.4	15	289	15.8	23	280	5.9	24	300	11.6	14	284	14.4	13	316	7.9	18	246	5.9				12	287	3.9	11	296	5.9	14	281	19.4
5,000				14	278	9.0	19	282	12.5	11	276	20.6	21	281	6.4	22	298	12.7	11	296	20.3	11	309	8.4	16	257	6.8										13	278	21.2
6,000				14	278	9.9	17	292	12.0				17	291	9.4	20	297	16.0				11	306	11.7	11	245	5.1												
8,000				14	286	13.4	10	324	15.4				11	290	11.0	16	285	18.6																					
10,000				11	290	13.5										12	275	17.7																					
12,000				10	272	16.3										10	284	17.6																					

See footnotes at end of table.

TABLE 3.—*Maximum free-air wind velocities (m. p. s.), for different sections of the United States, based on pilot-balloon observations during December 1940*

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Station
Northeast [1]	44.2	WSW	1,090	16	Toledo, Ohio	49.2	W	4,970	12	Caribou, Maine	70.4	WNW	5,870	18	Caribou, Maine.
East-Central [2]	43.8	SW	2,310	16	Elkins, W. Va	44.7	NW	5,000	7	Nashville, Tenn	66.0	WSW	13,046	20	Greensboro, N. C.
Southeast [3]	30.1	ESE	1,190	24	Birmingham, Ala	39.2	SSW	3,880	27	Miami, Fla	56.0	WSW	11,900	31	Jacksonville, Fla.
North-Central [4]	47.5	NW	2,150	6	Rapid City, S. Dak	43.2	W	4,660	9	Huron, S. Dak	67.4	NW	8,180	26	Duluth, Minn.
Central [5]	44.2	WSW	1,470	5	Des Moines, Iowa	50.4	NW	4,300	29	Wichita, Kans	64.8	NW	9,020	28	Wichita, Kans.
South-Central [6]	37.4	N	1,710	26	Abilene, Tex	65.8	NNW	4,390	27	Abilene, Tex	66.0	NW	21,310	5	Abilene, Tex.
Northwest [7]	38.7	E	260	16	Tatoosh Island, Wash.	55.8	W	3,200	5	Havre, Mont	67.0	W	13,870	21	Billings, Mont.
West-Central [8]	40.8	WNW	2,480	6	Cheyenne, Wyo	48.8	W	3,280	5	Sheridan, Wyo	92.2	NW	8,910	28	Casper, Wyo.
Southwest [9]	57.5	NW	2,278	25	Roswell, N. Mex	47.0	S	3,810	28	Sandberg, Calif	78.9	WNW	8,760	25	Las Vegas, Nev.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and Northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, Southern Ohio, Kentucky, Eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except extreme West Texas) and Western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, Northern Nevada, and Northern California.
[9] Southern California, Southern Nevada, Arizona, New Mexico, and extreme West Texas.

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during December 1940, classified according to the potential temperatures (10° intervals between 290° and 409° A.) with which they are identified (based on radiosonde observations)*

Stations	Anchorage, Alaska			Barrow, Alaska			Bethel, Alaska			Bismarck, N. Dak.		
Potential temperatures ° A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.
290–299	13	6.4	−43.4	20	6.4	−45.7	8	7.3	−53.1	4	6.8	−43.5
300–309	26	7.7	−48.9	19	6.9	−51.8	15	8.4	−55.5	16	7.5	−41.9
310–319	19	9.4	−57.3	18	9.6	−59.3	6	9.0	−57.2	29	9.3	−52.8
320–329	9	10.5	−60.8	1	10.5	−62.0	3	9.7	−55.7	17	10.4	−56.5
330–339	1	12.2	−67.0	1	10.3	−55.0				5	10.7	−54.8
340–349										4	11.2	−53.0
350–359				1	11.0	−51.0				4	12.2	−56.8
360–369										5	12.7	−55.4
370–379	1	13.0	−54.0	1	13.3	−56.0						
380–389										3	14.1	−55.0
390–399	1	13.7	−53.0	2	14.2	−55.5				2	14.6	−56.0
400–409	1	14.4	−50.0							4	15.3	−56.5
Weighted means		8.6	−52.0		8.0	−52.4		8.4	−55.2		10.1	−51.9
Mean potential temperature ° A. (weighted)	312.0			309.6			305.4			328.8		
Number days with observations	29			23			16			31		

Stations	Brownsville, Tex.			Charleston, S. C.			Denver, Colo.			El Paso, Tex.		
Potential temperatures ° A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature ° C.
290–299												
300–309							3	6.7	−31.3	1	6.4	−27.0
310–319	2	7.1	−29.0	3	7.5	−32.3	24	9.1	−49.9	14	8.5	−41.0
320–329	15	9.1	−39.7	17	9.9	−48.2	25	10.5	−55.8	20	10.3	−52.8
330–339	16	11.0	−51.4	21	11.4	−55.1	7	11.6	−60.7	10	11.4	−57.0
340–349	7	13.1	−65.3	16	12.8	−63.2	2	12.0	−58.0	6	12.5	−61.7
350–359	4	13.8	−65.2	5	13.6	−65.4	4	12.7	−60.2	7	13.8	−67.4
360–369	7	15.0	−71.6	5	14.8	−70.2	2	14.0	−62.0	4	14.6	−68.8
370–379	10	15.4	−71.3	3	15.4	−69.3	5	14.4	−62.2	6	15.5	−72.8
380–389	4	16.2	−73.2	2	15.6	−68.0	2	15.6	−70.0	6	15.8	−71.0
390–399	7	16.7	−72.9	9	16.0	−68.0				4	16.2	−70.2
400–409	3	16.8	−68.3	4	16.9	−69.8	2	16.2	−65.5	3	16.4	−67.7
Weighted means		12.9	−58.9		12.5	−58.8		10.8	−54.9		12.1	−57.9
Mean potential temperature ° A. (weighted)	353.3			349.1			331.6			344.4		
Number days with observations	26			29			28			27		

Stations	Ely, Nev.			Fairbanks, Alaska			Great Falls, Mont.			Joliet, Ill.		
Potential temperatures °A	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290–299	1	7.9	−53.0	6	6.9	−50.0	3	7.3	−49.0	1	6.4	−39.0
300–309	7	7.8	−46.1	17	8.3	−52.6	9	7.9	−46.9	5	8.2	−48.2
310–319	13	8.3	−43.2	11	9.1	−54.6	15	9.7	−56.9	19	9.1	−49.6
320–329	24	10.8	−57.2	1	9.4	−50.0	14	10.8	−59.4	25	10.5	−57.2
330–339	12	11.7	−61.4				2	11.2	−59.0	8	11.4	−60.1
340–349	2	12.6	−64.0	1	11.9	−61.0	2	11.9	−59.5	2	12.4	−65.0
350–359	3	12.8	−60.0							1	13.1	−65.0
360–369	1	14.5	−67.0									
370–379	3	13.8	−59.3				2	13.0	−52.0	3	14.3	−63.7
380–389	6	15.4	−67.5				4	14.6	−61.2	3	15.1	−64.7
390–399	10	15.4	−63.0							4	15.2	−60.2
400–409	3	16.3	−65.7				3	15.7	−61.0	4	16.1	−64.2
Weighted means		11.6	−56.8		8.4	−52.9		10.5	−56.0		11.0	−56.1
Mean potential temperature °A (weighted)	341.1			307.1			328.7			335.0		
Number days with observations	30			18			26			30		

Stations	Ketchikan, Alaska			Lakehurst, N. J.			Medford, Oreg.		
Potential temperatures °A	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290–299	3	5.8	−36.3				1	5.6	−32.0
300–309	11	7.3	−43.9	6	7.2	−40.0	4	7.2	−39.5
310–319	19	9.4	−55.4	13	8.7	−45.2	13	8.6	−45.2
320–329	10	10.4	−58.8	15	10.3	−54.3	25	10.8	−58.2
330–339	1	11.9	−67.0	12	11.5	−50.5	10	11.5	−59.1
340–349	1	12.4	−64.0	5	12.4	−62.2	3	12.7	−64.0
350–359									
360–369				3	13.5	−60.7	5	13.5	−63.0
370–379	1	13.3	−55.0	3	14.1	−62.3	2	14.3	−62.0
380–389							5	15.0	−64.2
390–399	2	13.7	−47.5	1	16.2	−67.0	3	15.9	−67.7
400–409							2	16.2	−65.0
Weighted means		9.3	−52.4		10.5	−53.5		11.2	−56.3
Mean potential temperature °A (weighted)	318.5			330.1			336.7		
Number days with observations	21			26			28		

TABLE 4.—*Mean altitudes and temperatures of significant points identifiable as tropopauses during December 1940, classified according to the potential temperatures (10° intervals between 290° and 409° A.) with which they are identified (based on radiosonde observations)*—Continued

Stations	Miami, Fla.			Nashville, Tenn.			Nome, Alaska			Oakland, Calif.			Oklahoma City, Okla.			Omaha, Nebr.			Phoenix, Ariz.		
Potential temperatures °A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290-299							17	6.7	−46.7												
300-309							14	8.3	−54.9	5	7.1	−38.2	1	7.4	−40.0	5	7.0	−38.2	1	7.2	−35.0
310-319	2	7.2	−26.5	8	9.2	−40.9	14	8.9	−56.0	7	8.6	−45.1	7	8.6	−45.3	21	8.9	−46.1	5	7.9	−39.2
320-329	6	9.1	−39.2	28	10.2	−52.9	3	9.4	−53.3	22	10.4	−54.7	24	10.3	−54.9	20	10.4	−55.0	17	10.0	−48.4
330-339	24	11.5	−56.0	12	11.6	−60.2	2	10.0	−50.0	12	11.4	−57.3	10	11.6	−59.0	7	11.0	−55.7	13	11.3	−55.2
340-349	13	12.9	−63.5	12	12.4	−61.7				1	13.1	−69.0	2	12.6	−63.0	4	12.5	−61.8	3	12.5	−58.3
350-359	10	14.0	−68.0	2	13.2	−63.0	1	11.4	−51.0	4	13.6	−66.0	4	13.4	−66.5	2	12.7	−58.0			
360-369	12	15.3	−75.9	2	14.4	−65.5	1	12.4	−59.0	3	13.5	−61.7	1	14.3	−65.0	1	14.1	−65.0	6	14.5	−68.8
370-379	3	15.8	−77.3	6	14.5	−66.0				2	17.7	−73.5	5	15.0	−68.6	2	14.8	−68.5	6	15.5	−71.3
380-389	7	16.4	−76.3	4	15.3	−67.5				4	15.3	−65.0	2	15.6	−70.5	2	14.7	−60.5	4	15.9	−72.8
390-399	3	16.6	−72.7	9	16.0	−68.1				6	15.7	−63.0	2	16.2	−70.0	5	15.1	−59.2	2	16.6	−72.0
400-409	4	17.2	−72.5	1	16.6	−72.0				5	16.2	−64.8	2	16.1	−64.5	4	15.8	−61.5	2	17.0	−72.0
Weighted means		13.3	−63.4		12.0	−58.9		8.2	−52.2		11.8	−56.7		11.6	−57.9		10.8	−53.1		12.1	−57.1
Mean potential temperature °A (weighted)	352.2			344.1			308.1			343.2			338.3			336.7			345.1		
Number days with observations	28			29			26			29			24			26			24		

Stations	Portland, Maine			San Diego, Calif.			Sault Ste Marie, Mich.			Seattle, Wash.			Atlantic Station No. 1			Late report, November 1940 Barrow, Alaska		
Potential temperatures °A.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.	Number of cases	Mean altitude (km.) m. s. l.	Mean temperature °C.
290-299	3	6.1	−38.7				9	6.6	−43.8							14	7.1	−49.7
300-309	11	7.6	−43.5				9	6.9	−39.2	9	8.3	−51.3	1	7.6	−45.0	28	8.2	−52.6
310-319	21	8.8	−48.0	2	8.6	−42.0	18	9.6	−56.1	14	9.1	−51.4	8	8.9	−44.9	19	9.4	−57.2
320-329	22	10.2	−54.7	10	10.2	−53.3	12	10.4	−58.0	20	10.4	−55.2	12	10.2	−53.1	12	10.7	−61.7
330-339	10	11.4	−60.5	11	11.1	−55.7	1	10.9	−57.0	5	11.5	−59.8	10	11.7	−60.7	2	11.2	−59.5
340-349	2	11.4	−55.0	3	12.1	−56.7	3	11.4	−56.0	1	12.0	−58.0	3	12.8	−65.7	2	11.2	−55.0
350-359				1	12.3	−53.0				1	12.0	−57.0	3	12.8	−60.3	1	11.6	−55.0
360-369	1	12.7	−58.0	2	14.1	−64.5							1	14.8	−71.0	1	12.2	−54.0
370-379	3	14.7	−65.0	1	14.6	−64.0	2	13.0	−53.5	1	13.4	−57.0	3	14.1	−61.7			
380-389	2	14.2	−57.5	1	15.5	−65.0	4	14.0	−57.8				3	15.4	−67.7			
390-399	3	15.3	−62.7							1	15.1	−62.0	5	16.0	−67.0			
400-409	1	15.3	−58.0	1	17.2	−72.0	4	15.1	−57.2	2	15.4	−58.5	2	16.6	−66.0	1	14.6	−53.0
Weighted means		10.0	−52.3		11.4	−55.7		9.8	−52.3		10.2	−54.4		12.0	−57.9		9.0	−54.8
Mean potential temperature °A. (weighted)	327.2			337.8			325.7			325.5			343.9			312.4		
Number days with observations	26			20			23			30			17			29		

Information contained in footnotes to Table 1 are also applicable to Table 4.

AEROLOGICAL OBSERVATIONS FOR THE YEAR 1940

By EARL C. THOM

At the end of 1940, radiosonde observations were being made at 26 Weather Bureau stations and at 5 Navy stations, while 3 other Navy stations were using airplanes to record upper-air conditions. At the end of the previous year radiosonde observations were being made at 25 Weather Bureau stations, 3 Navy stations and 1 Army station, while 6 Navy stations were making airplane observations. Changes were made in the location of several Weather Bureau radiosonde stations in the United States and several new stations were established in Alaska during the latter months of the year. The stations at which upper air observations were made during each month of the year are shown in Table 4 which tabulates the number of observations made at the various stations.

Valuable upper air data were obtained during the 1940 hurricane season from radiosonde observations made at San Juan, Puerto Rico as well as from special observations made at several of the regular radiosonde stations. Upper air data were also obtained in the ocean area between 40° to 52° N. latitude and 47° to 55° W. longitude from radiosonde observations made by United States Coast Guard Cutters while on ice patrol duty.

Radiosonde observations were begun in May as part of a regular weather reporting service established on board Coast Guard Cutters in the Atlantic Ocean in areas, termed Atlantic Stations No. 1 and No. 2. For the location of these stations the reader is referred to the footnote of table 4.

Monthly mean values of temperature, pressure, and relative humidity for all the standard levels of the free air have been published each month as Table 1 under Aerological Observations in the MONTHLY WEATHER REVIEW.

Table 1 for the year 1940, tabulates annual mean pressures, temperatures, and relative humidities for all stations for which such data were available during the entire

year as well as for Juneau where such observations were not made during the months of July and August. The annual mean values shown in Table 1 are computed by averaging the corresponding mean monthly values so that data for all months are given the same weight. The reader may find the number of observations for each month and level by referring to the previously published monthly tables.

Annual mean values for both 1939 and 1940 are available for twelve stations in the United States. These stations are shown in the annual table No. 1 for each of these 2 years and are as follows: El Paso, Tex., Lakehurst, N. J., Nashville, Tenn., Norfolk, Va., Oakland, Calif., Oklahoma City, Okla., Omaha, Nebr., Pensacola, Fla., San Diego, Calif., Sault Ste. Marie, Mich., Seattle, Wash., and Washington, D. C.

Based on the available annual mean values it is found that temperatures at standard levels from the surface to 2,000 meters, inclusive, were higher in 1940 than in 1939 over the southwestern part of the United States and were generally lower than last year over the eastern half of the country at these levels. At standard levels, from 3,000 meters to 9,000 meters, 1940 temperatures were generally lower than last year.

At most stations the annual mean relative humidities at all levels were several percent higher than last year. In this connection it is noted that precipitation for the country as a whole was considerably below normal in 1939 and somewhat above normal in 1940.

At levels 3,000 meters and lower the annual mean pressures were either the same or lower in 1940 than in 1939 at nine of the stations for which data are available. At Seattle, where the greatest decrease was noted, the annual mean pressure averaged nearly 3 millibars lower than last year at these levels. At three stations, Sault Ste. Marie, Omaha, and Oklahoma City the corresponding annual mean pressures averaged about 1½ millibars higher than in 1939.

At the end of 1940, observations were being made 4 times daily at nearly all of the 132 Weather Bureau pilot-balloon stations. Of these stations 123 were in the United States proper, 7 in Alaska, 1 in Puerto Rico and 1 in Swan Island. This represented an addition in the number of pilot-balloon stations since the end of 1939 of 25 stations in the United States, 3 in Alaska and 1 in Swan Island. Pilot-balloon work was moved from Elmira, N. Y., to Binghamton, N. Y., during the year. All pilot-balloon stations were using helium gas for inflation at the end of the year.

To extend still further the Weather Bureau investigations of winds at higher levels of the free air, more stations were equipped during the year with the larger 100-gram balloons for use in making the 5 p. m. (e. s. t.) observations. The higher ascensional rate of these ballons is resulting in observations of wind conditions at much higher levels than formally The number of stations using the 100-gram balloons was 12 at the end of 1938, 27 at the end of 1939 and 41 at the end of 1940.

All Weather Bureau pilot-balloon data which were reduced to punch card form by the W. P. A. Weather Project at New Orleans during 1939 were tabulated and summarized by the project during 1940. About 14 million regular hourly surface airway observations were coded and reduced to punch cards by the project in 1940 and in addition charts and tables showing summaries of pilot-balloon and surface airway observations were prepared in final form and the printing of the "Meteorological Atlas of the Airways" was begun.

During the first 8 months of the year the minimum free-air temperatures published were those selected from the temperatures recorded only at "standard" levels, while during the remainder of the year minimum temperatures for the month were selected from the lowest temperature recorded over each station at any level. The lowest published free-air temperature over the United States, −84.2° C. (−119.6° F.) was observed at 16,400 meters (m. s. l.) over Miami, Fla., on November 30. A lower temperature, −92.6° C. (−134.5° F.) was, however, observed over Swan Island at 17,800 meters on December 28. The corresponding minimum temperatures recorded in 1939 were −80.6° C. over Atlanta, Ga., for the United States, and −85.1° C. over Swan Island.

Monthly resultant wind directions and velocities have been computed for the 1,500- and 3,000-meter levels from the 5 a. m. (e. s. t.) observations for all stations and have been shown each month in the MONTHLY WEATHER REVIEW on charts VIII and IX. Similar 5 p. m. resultants have been computed for the 5,000- and 10,000-meter levels and shown on charts X and XI. Monthly resultants (5 p. m., e. s. t.) have also been computed for all levels at 39 selected stations. These resultants have been published regularly in the REVIEW as table 2 of the Aerological Summary. The list of stations furnishing data for table 2 was revised, early in the year 1940, to conform as closely as practicable with the radiosonde stations then in operation.

The 1940 annual 5 p. m. resultants are shown in table 2 for the selected list of stations. At most of the standard levels below 5,000 meters stations located in the western third of the country had annual resultant directions this year considerably to the southward of the corresponding 1939 resultants and somewhat to the southward of normal while the opposite was true for these levels at most stations to the eastward. At the 2,000- and 2,500-meters levels the 1940 annual resultant velocities were higher than the corresponding 1939 values over the southwest and along the upper Pacific coast and were generally lower than the previous year at these levels for other stations.

In the southwestern part of the United States where annual resultant wind velocities were higher in 1940 than in 1939 and where the turning of the annual resultant winds was to the north of normal in 1939 and to the south of normal in 1940, the annual precipitation for this area was below normal in 1939 (California 67 percent of normal, Arizona 93 percent of normal) while precipitation was much above normal in 1940 (California 156 percent of normal, Arizona 124 percent of normal).

Table 3 shows the maximum free-air wind velocities and their directions for various sections of the United States during the year 1940, as determined by pilot balloon observations. The extreme velocity for the year 98.4 meters per second (220 miles per hour). This velocity was 2.9 meters per second higher than the corresponding extreme of 1939. In both 1939 and 1940 the extreme wind velocity for the year occurred above 5,000 meters (m. s. l.). During the years 1939 and 1940 at levels lower than 2,500 meters the extreme wind velocity was 57.5 meters per second while for the same period at levels between 2,500 meters and 5,000 meters this extreme was 67.4 meters per second. When the maximum wind velocities for the nine sections of the country

are averaged by each of the four seasons of 1940 it is found that winter is the season of highest wind velocities at all levels, and that at levels above 2,500 meters Autumn has the next highest winds, while Summer is the season of lowest maximum wind velocities at all levels.

Table 4 gives a tabulation by months of the altitude of the level at which a mean temperature of 0° C. was observed at all stations making either airplane or radiosonde observations. The level of mean freezing temperature was the highest in July when it was observed at a minimum elevation of 2,900 meters over Sault Ste. Marie and sloped upward to a maximum of 5,300 meters over Phoenix. The level of freezing during the month of July 1940 was 800 meters lower over Sault Ste. Marie than during the same month of 1939 and was 300 meters lower over San Antonio.

More detailed comparison of upper-air conditions during the year, of 1939 and 1940 can be made by reference to the 1939 Annual Summary of Aerological Observations which was published in the MONTHLY WEATHER REVIEW for December 1939.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during year 1940*

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	Bismarck, N. Dak. (505 meters)				Charleston, S. C. (14 meters)				Denver, Colo. (1,616 meters)				El Paso, Tex. (1,194 meters)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	348	957	3.3	79	346	1,016	14.0	86	346	838	6.8	70	338	882	15.6	46
500					345	960	15.1	70								
1,000	348	901	5.8	69	345	904	12.9	65								
1,500	348	847	4.6	65	345	852	10.5	63					338	851	16.7	44
2,000	348	796	2.6	64	345	802	8.3	59	345	800	9.0	62	338	802	13.8	42
2,500	348	749	0.3	62	345	755	6.0	57	345	753	6.4	58	338	756	10.6	42
3,000	348	703	−2.3	61	345	710	3.5	54	345	708	3.3	57	338	711	7.1	44
4,000	346	619	−8.2	58	342	627	−1.6	48	344	624	−3.5	60	335	629	0.0	45
5,000	345	544	−14.6	55	342	552	−7.4	45	338	550	−10.3	61	335	554	−6.9	46
6,000	339	476	−21.4	53	339	485	−13.6	43	334	482	−17.1	58	332	487	−13.6	43
7,000	336	414	−28.8	51	338	425	−20.4	42	331	421	−24.3	56	328	426	−20.5	40
8,000	320	359	−36.5		334	370	−27.8	41	328	367	−31.7	54	325	372	−27.9	39
9,000	309	310	−43.9		329	321	−35.3		324	317	−39.6		323	322	−35.4	
10,000	296	267	−50.6		324	278	−42.8		317	274	−46.8		319	280	−42.8	
11,000	285	229	−54.9		315	239	−49.7		302	235	−52.6		314	240	−49.7	
12,000	274	195	−56.6		306	205	−55.1		284	201	−56.1		309	206	−55.1	
13,000	255	166	−57.1		293	175	−59.4		272	172	−58.3		304	176	−59.2	
14,000	239	142	−57.1		284	148	−62.6		251	146	−59.7		296	149	−62.5	
15,000	209	122	−57.8		265	126	−65.1		229	124	−61.3		284	127	−65.7	
16,000	186	104	−58.4		252	107	−66.8		208	106	−62.2		274	108	−67.8	
17,000					224	91	−67.1		180	90	−62.1		232	91	−67.9	
18,000					196	77	−65.7						167	77	−66.0	

Altitude (meters) m. s. l.	Ely, Nev. (1,908 meters)				Joliet, Ill. (178 meters)				Juneau, Alaska (49 meters)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	346	810	5.6	60	332	996	6.2	84	276	1,007	5.5	74
500					331	957	7.3	74	276	950	3.2	74
1,000					331	901	5.8	71	274	895	−0.2	76
1,500					331	847	4.0	70	271	841	−2.7	78
2,000	346	801	7.5	56	330	796	1.8	68	260	789	−5.3	78
2,500	346	754	7.0	51	329	748	−0.4	65	253	740	−7.9	77
3,000	346	709	3.7	51	328	703	−2.8	62	247	693	−10.8	74
4,000	344	626	−3.2	50	325	619	−8.1	57	238	608	−16.8	68
5,000	342	551	−10.3	50	325	543	−14.2	54	227	532	−23.5	65
6,000	341	483	−17.4	49	321	475	−20.9	51	212	463	−30.6	
7,000	339	422	−24.7	47	312	414	−28.1	49	204	401	−37.9	
8,000	336	367	−32.3	44	303	360	−35.4		185	346	−44.9	
9,000	330	317	−39.9		289	311	−42.5		169	297	−50.6	
10,000	324	274	−47.2		274	268	−48.9		163	254	−53.8	
11,000	319	235	−53.4		260	229	−53.6		143	218	−53.5	
12,000	315	201	−57.1		248	196	−56.4		130	187	−51.5	
13,000	300	171	−58.9		226	167	−57.8		122	160	−50.3	
14,000	293	146	−60.0		209	142	−58.7		109	137	−50.2	
15,000	285	124	−61.5		194	121	−59.7					
16,000	269	106	−62.4		171	104	−60.5					
17,000	226	90	−62.3		140	87	−60.5					
18,000	147	77	−61.4									

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	Lakehurst, N. J.[1] (39 m.)				Medford, Oreg. (401 m.)				Nashville, Tenn. (180 m.)				Norfolk, Va.[1,2] (3 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	363	1,012	6.8	83	330	968	12.3	69	345	996	11.6	78	282	1,019	11.7	78
500	363	956	7.0	70	330	957	12.6	67	345	959	12.1	73	282	961	11.4	65
1,000	363	900	5.3	67	330	901	11.5	61	345	903	10.1	71	281	905	8.9	61
1,500	362	846	3.3	64	330	849	8.8	61	345	850	8.0	69	278	852	6.5	59
2,000	362	796	1.4	61	330	799	6.0	62	345	800	5.9	67	276	801	4.3	54
2,500	361	747	−0.6	57	330	751	3.5	59	345	752	3.7	63	276	753	1.9	49
3,000	359	702	−2.7	54	330	706	0.8	55	342	707	1.3	60	276	708	−0.7	46
4,000	353	618	−7.9	51	326	623	−5.3	50	337	624	−4.0	56	269	624	−6.0	40
5,000	342	542	−13.7	49	324	548	−11.6	46	333	549	−9.9	52	198	549	−11.7	36
6,000	340	474	−20.2	48	319	480	−18.4	44	330	482	−16.2	49				
7,000	340	414	−27.2	49	315	419	−25.8	43	329	421	−23.1	47				
8,000	336	360	−34.2		308	364	−33.6		325	366	−30.4	47				
9,000	332	311	−41.1		297	314	−41.2		321	318	−38.1					
10,000	322	268	−47.3		289	271	−48.3		313	274	−45.1					
11,000	312	230	−52.2		276	232	−54.0		302	236	−51.3					
12,000	299	197	−55.5		258	198	−57.6		298	202	−55.8					
13,000	284	168	−57.6		245	169	−59.0		291	172	−58.9					
14,000	268	144	−59.1		233	144	−59.3		276	147	−61.1					
15,000	241	122	−59.8		215	123	−60.4		262	125	−62.8					
16,000	211	104	−60.4		196	105	−61.1		245	106	−63.8					
17,000	178	89	−60.0		178	89	−61.0		218	90	−63.8					
18,000									186	77	−63.3					
19,000																

Altitude (meters) m. s. l.	Oakland, Calif. (2 m.)				Oklahoma City, Okla. (391 m.)				Omaha, Nebr. (301 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	346	1,016	13.2	81	342	971	12.0	75	348	982	8.1	75
500	346	958	13.1	74	342	958	12.7	72	348	959	8.7	70
1,000	346	902	13.5	58	342	903	12.3	63	348	902	8.1	65
1,500	345	850	11.7	51	342	851	10.7	59	348	849	6.6	62
2,000	345	800	9.2	46	341	801	8.8	55	346	798	4.7	60
2,500	345	753	6.4	42	341	754	6.3	52	346	751	2.3	58
3,000	345	708	3.5	39	340	709	3.5	51	345	706	−0.3	56
4,000	344	626	−2.5	37	335	626	−2.6	50	344	622	−6.1	55
5,000	343	551	−9.1	36	333	551	−9.0	47	341	547	−12.2	52
6,000	342	483	−16.0	36	330	484	−15.8	44	336	479	−18.8	49
7,000	341	422	−23.3	35	326	423	−22.9	42	331	418	−25.8	47
8,000	340	368	−31.1	35	324	368	−30.5	41	329	363	−33.3	
9,000	338	318	−39.0		315	319	−38.2		327	314	−40.8	
10,000	335	275	−46.7		307	275	−45.8		319	271	−47.6	
11,000	320	236	−53.2		300	236	−52.3		309	232	−52.9	
12,000	322	201	−57.6		287	202	−57.0		305	199	−55.9	
13,000	320	172	−59.8		276	172	−60.2		290	170	−57.6	
14,000	315	146	−60.7		256	146	−62.7		268	145	−58.8	
15,000	302	124	−61.9		235	125	−65.3		246	123	−60.1	
16,000	286	106	−63.2		210	106	−66.8		228	105	−60.7	
17,000	258	90	−63.0		186	90	−66.7		183	90	−60.8	
18,000	204	76	−62.0		153	76	−65.2		151	76	−60.2	
19,000	136	65	−61.1									

See footnotes at end of table.

TABLE 1.—*Mean free-air barometric pressure in millibars, temperature in degrees centigrade, and relative humidities in percent, obtained by airplanes and radiosondes during year 1940*—Continued

Stations and elevations in meters above sea level

Altitude (meters) m. s. l.	Pearl Harbor, T. H.[1 3] (6 m.)				Pensacola, Fla.[1 3] (24 m.)				Phoenix, Ariz. (339 m.)				San Diego, Calif.[1] (19 m.)				Sault Ste. Marie, Mich. (221 m.)				Seattle, Wash.[1 3] (27 m.)				Washington, D. C.[1] (7 m.)			
	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity	Number of observations	Pressure	Temperature	Relative humidity
Surface	364	1,014	21.8	85	347	1,016	17.0	79	348	973	19.8	47	346	1,012	16.2	82	347	990	2.1	86	309	1,013	11.4	78	333	1,017	8.6	78
500	364	959	20.8	79	347	961	16.2	69	348	955	22.9	42	346	957	15.3	68	347	956	2.5	83	309	957	10.3	68	333	958	8.9	68
1,000	364	905	17.5	81	347	906	14.0	64	348	902	21.5	38	346	902	15.6	50	347	899	0.7	80	308	902	7.9	65	333	902	7.1	67
1,500	364	853	15.0	74	347	854	11.7	59	348	851	18.0	37	345	850	14.4	39	346	844	−1.3	78	306	848	5.0	66	332	848	5.1	66
2,000	364	804	12.3	62	347	804	9.6	53	348	802	14.2	39	344	801	12.2	35	346	792	−3.4	76	302	798	2.2	66	332	798	3.2	62
2,500	364	757	11.8	44	346	756	7.2	48	348	755	10.6	40	344	754	9.5	33	346	744	−5.6	74	300	749	−0.6	63	332	749	1.1	58
3,000	364	714	9.9	32	346	712	4.6	46	347	711	7.3	41	329	710	6.5	33	346	697	−7.9	71	297	703	−3.2	58	330	704	−1.2	55
4,000	361	632	4.9	23	333	629	−1.1	44	342	629	0.5	42	312	630	0.0	34	341	612	−13.2	67	285	619	−8.9	55	330	620	−6.5	53
5,000					278	554	−7.1	43	341	554	−6.3	41	295	553	−7.0	35	338	536	−19.1	63	274	543	−15.2	54	328	545	−12.3	52
6,000					248	487	−13.3	43	339	487	−13.3	40	290	486	−13.8	39	333	468	−25.8	60	261	475	−21.6	54	321	477	−18.7	52
7,000					241	426	−20.2	44	337	426	−20.5	39	285	425	−21.1	42	327	407	−32.8		252	414	−28.8	57	315	417	−25.5	52
8,000					224	372	−27.4	46	333	372	−28.1	37	271	370	−28.7		323	352	−39.8		235	360	−36.1	54	229	362	−32.6	
9,000					215	323	−34.6		327	322	−35.9	36	264	321	−36.3		314	304	−46.2		211	311	−43.1		220	314	−39.7	
10,000					193	279	−41.8		312	279	−43.4		255	278	−43.5		306	261	−51.3		194	268	−49.1		191	270	−46.1	
11,000					174	241	−48.8		300	240	−50.2		240	239	−50.2		293	224	−54.1		171	230	−53.1		151	232	−51.5	
12,000									288	206	−55.4		227	204	−55.6		276	191	−55.2		151	197	−54.5		106	199	−55.5	
13,000									275	175	−59.0		199	175	−59.6		258	164	−55.6		142	169	−54.5					
14,000									258	149	−61.9		180	149	−62.3		243	140	−56.0		130	145	−55.0					
15,000									240	127	−64.6		160	127	−64.9		211	120	−56.8									
16,000									214	108	−66.8		135	108	−66.5		168	103	−57.3									
17,000									179	91	−67.1																	
18,000									140	77	−65.6																	

[1] Navy stations.
[2] Airplane observations.
[3] Raobs and Apobs.

NOTE.—All data are based on observations during 12 months except at Juneau, for which only 10 months data were available.

At some stations data were missing during 1 or 2 months at higher levels. Data were not published for any level where observations were missing for 2 months in the same season.

TABLE 2.—*Free-air resultant winds based on pilot balloon observations made near 5 p. m. (75th meridian time) during the year 1940. Directions given in degrees from North (N=360°, E=90°, S=180°, W=270°)—Velocities in meters per second*

Altitude (meters) m. s. l.	Abilene, Tex. (537 m.)			Albuquerque, N. Mex. (1,630 m.)			Atlanta, Ga. (299 m.)			Billings, Mont. (1,095 m.)			Bismarck, N. Dak. (512 m.)			Boise, Idaho (870 m.)			Brownsville, Tex. (7 m.)			Buffalo, N. Y. (220 m.)			Burlington, Vt. (132 m.)			Charleston, S. C. (18 m.)			Chicago, Ill. (192 m.)			Cincinnati, Ohio (157 m.)			Denver, Colo. (1,627 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	353	187	1.3	362	256	1.6	344	290	1.4	354	304	1.0	357	324	0.9	353	316	1.7	344	119	3.8	341	262	2.7	351	240	0.7	344	195	1.1	333	288	1.2	352	256	1.3	358	38	0.8
500							344	284	1.7										344	128	4.2	341	257	4.3	347	250	2.4	343	218	1.9	333	276	1.5	352	253	2.4			
1,000	350	190	2.0				334	276	2.4				349	303	1.9	353	319	1.6	315	149	2.4	305	261	5.6	330	267	4.1	330	255	3.0	299	264	3.4	318	252	3.5			
1,500	343	215	2.3				315	278	3.3	354	277	2.1	313	295	2.6	353	289	1.3	280	198	0.9	261	268	5.9	285	280	5.2	310	268	4.2	271	272	4.9	297	264	5.1			
2,000	326	236	3.1	362	252	2.1	291	282	4.6	344	276	3.4	273	289	4.2	346	265	2.3	230	255	1.4	230	278	7.0	236	286	6.5	273	276	5.7	242	280	6.1	266	271	6.3	358	17	.9
2,500	312	259	4.4	358	265	2.8	270	287	6.2	327	277	5.3	256	295	6.4	325	260	4.0	203	258	2.3				165	294	7.1	253	277	6.3	222	283	7.5	235	280	7.4	347	325	1.2
3,000	300	272	5.6	350	277	4.0	226	285	7.3	317	276	6.6	232	293	8.1	303	257	5.1										219	276	7.6	187	287	8.8	204	286	9.0	341	297	2.5
4,000	272	281	7.9	313	289	6.2	239	284	9.5	279	278	10.0	187	296	10.8	247	254	6.8																			319	293	6.5
5,000	251	285	9.6	281	288	8.3	214	284	12.7	236	281	12.2				206	259	8.1																			285	292	9.5
6,000	225	286	10.6	257	289	9.6	199	281	13.9	206	284	13.4																									244	291	11.6
8,000	183	284	12.6	210	289	11.6																															180	292	14.8
10,000				159	286	13.2																																	

Altitude (meters) m. s. l.	El Paso, Tex. (1,196 m.)			Ely, Nev. (1,910 m.)			Grand Junction, Colo. (1,413 m.)			Greensboro, N. C. (271 m.)			Havre, Mont. (766 m.)			Jacksonville, Fla. (14 m.)			Las Vegas, Nev. (570 m.)			Little Rock, Ark. (79 m.)			Medford, Oreg. (410 m.)			Miami, Fla. (10 m.)			Minneapolis, Minn. (261 m.)			Mobile, Ala. (10 m.)			Nashville, Tenn. (194 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	364	245	1.5	354	210	1.6	350	310	1.3	323	268	1.2	329	272	0.9	344	96	1.2	366	148	1.6	347	153	0.5	341	310	1.0	361	93	1.9	344	286	0.8	358	170	1.0	333	274	1.1
500										323	258	2.0				340	165	0.9				346	217	0.9	341	309	1.2	360	94	2.1	344	278	1.3	355	204	1.3	333	257	1.5
1,000										317	259	3.3	329	263	2.2	322	247	2.1	366	161	1.7	325	232	2.0	339	256	0.9	352	93	0.8	312	281	2.4	326	278	1.3	322	257	2.4
1,500	364	247	1.9				350	308	1.4	314	273	4.6	329	266	4.5	302	269	3.7	363	185	1.9	308	265	3.0	334	216	2.2	338	274	0.6	296	280	3.9	308	295	2.6	302	268	3.5
2,000	361	253	2.3	354	213	1.9	350	295	1.6	296	283	6.4	320	269	5.6	286	276	4.6	357	215	2.7	297	279	4.1	321	216	3.6	318	267	1.7	262	286	5.6	288	298	3.7	279	280	4.6
2,500	358	263	3.2	353	222	2.5	344	263	2.2	270	288	8.3	296	266	6.8	276	277	5.7	351	230	3.2	273	283	5.4	289	213	4.2	311	268	2.7	231	291	7.5	271	290	4.8	256	283	6.1
3,000	345	267	4.1	346	234	2.9	338	255	3.3	254	289	9.7	268	268	8.0	270	277	6.7	345	243	4.0	244	290	6.9	262	219	4.4	300	262	3.7	196	297	9.3	256	284	6.2	228	288	7.5
4,000	312	273	5.5	316	257	4.6	300	268	5.0	224	288	12.2	191	271	9.8	249	277	8.8	334	255	5.4	214	292	9.6				278	263	5.4				209	277	7.2	154	288	8.5
5,000	258	273	6.7	268	264	6.4	248	279	6.7							232	276	10.9	318	264	6.9	140	294	9.3				250	265	7.1				167	275	8.1			
6,000	202	276	7.9	223	264	6.5										205	277	13.4	299	269	8.2							223	266	8.6									
8,000				169	276	9.7													247	270	9.8																		
10,000																			208	273	11.0																		
12,000																			175	266	14.0																		

TABLE 2.—*Free-air resultant winds based on pilot balloon observations made near 5 p. m. (75 meridian time) during the year 1940. Directions given in degrees from North (N=360°, E=90°, S=180°, W=270°)—Velocities in meters per second*—Continued

Altitude (meters) m. s. l.	New York, N. Y. (15 m.)			Oakland, Calif. (8 m.)			Oklahoma City, Okla. (402 m.)			Omaha, Nebr. (306 m.)			Phoenix, Ariz. (344 m.)			Rapid City, S. Dak. (982 m.)			St. Louis, Mo. (181 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	337	287	2.1	347	249	0.6	339	173	1.5	355	287	0.2	364	248	0.9	345	3	2.0	338	259	1.0
500	335	281	3.5	345	274	2.3	339	169	1.9	355	278	0.3	364	246	1.2				337	261	2.1
1,000	306	288	5.7	332	263	1.9	337	197	2.3	332	260	1.4	364	238	1.5	345	1	2.1	316	255	3.0
1,500	280	293	7.3	320	250	2.0	325	230	3.0	308	261	3.2	362	227	1.8	344	321	2.8	293	265	4.3
2,000	221	297	8.3	308	246	2.1	314	252	4.2	283	268	5.0	358	229	2.3	321	302	3.6	274	275	5.5
2,500				300	246	2.4	306	267	5.3	270	281	6.5	353	242	2.5	306	295	5.2	250	287	6.6
3,000				293	251	2.9	285	275	6.6	260	287	7.8	349	255	3.0	295	293	7.2	217	289	7.4
4,000				274	256	4.4	255	284	8.5	229	297	10.6	317	270	3.3	254	294	9.3			
5,000				250	259	5.6	230	293	10.4	200	298	13.1	283	275	4.2	223	291	11.5			
6,000							206	295	12.5	173	301	14.6	239	277	5.3						
8,000													169	275	6.1						

Altitude (meters) m. s. l.	San Antonio, Tex. (183 m.)			San Diego, Calif. (15 m.)			Sault Ste. Marie, Mich. (230 m.)			Seattle, Wash. (14 m.)			Spokane, Wash. (603 m.)			Washington, D. C. (10 m.)		
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity
Surface	358	117	1.2	346	281	3.6	318	299	2.0	334	255	1.3	330	216	1.8	341	287	1.3
500	358	118	1.7	346	288	2.7	318	293	2.8	334	212	1.4				341	282	2.7
1,000	346	146	1.1	323	274	1.3	288	288	3.5	304	203	2.7	330	212	2.5	320	276	4.5
1,500	323	200	1.1	307	267	0.8	250	294	3.8	274	204	3.4	318	224	3.5	292	283	6.8
2,000	300	252	2.0	294	255	1.5				235	210	3.9	294	230	4.3	261	288	8.3
2,500	279	264	3.1	281	250	1.9				213	215	4.1	247	240	4.9	241	287	9.9
3,000	266	277	4.2	261	252	2.9				179	224	4.5	222	246	5.8	216	287	10.8
4,000	240	287	6.2	234	254	4.1							176	255	8.2	164	288	12.3
5,000	201	286	7.6	215	255	4.8												
6,000	185	286	9.7	161	261	5.4												
8,000	138	280	12.6															

TABLE 3.—*Maximum free air wind velocities (m. p. s.), for different sections of the United States based on pilot balloon observations during the year 1940*

Section	Surface to 2,500 meters (m. s. l.)						Between 2,500 and 5,000 meters (m. s. l.)						Above 5,000 meters (m. s. l.)					
	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Month	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Month	Station	Maximum velocity	Direction	Altitude (m.) m. s. l.	Date	Month	Station
Northeast [1]	47.0	WSW	2,100	12	Nov.	Buffalo, N. Y.	62.4	WNW	3,610	22	Nov.	Binghamton, N.Y.	70.4	WNW	5,870	18	Dec.	Caribou, Maine.
East Central [2]	48.8	NW	2,240	10	Mar.	Washington, D. C.	63.9	NW	5,000	14	Feb.	Greensboro, N. C.	97.8	W	12,014	28	Nov.	Greensboro, N. C.
Southeast [3]	43.0	WNW	1,730	14	Feb.	Charleston, S. C.	55.6	SW	5,000	14	Nov.	Atlanta, Ga.	86.0	W	9,990	15	Jan.	Atlanta, Ga.
North Central [4]	47.5	NW	2,150	6	Dec.	Rapid City, S. Dak.	51.4	SW	4,600	6	July	Alpena, Mich.	80.0	WNW NW	9,830 7,730	21 22	Feb. Mar.	Rapid City, S. Dak. Fargo, N. Dak.
Central [5]	46.4	W	2,260	12	Nov.	Moline, Ill.	60.0	NW	4,960	25	Feb.	Moline, Ill.	74.0	W	11,580	27	Nov.	Wichita, Kans.
South Central [6]	41.2	NNW	2,470	1	May	Oklahoma City, Okla.	65.8	NNW	4,390	27	Dec.	Abilene, Tex.	78.0	WNW	21,230	12	Sept.	San Antonio, Tex.
Northwest [7]	41.3	W	1,972	6	May	Pocatello, Idaho	55.8	W	3,200	5	Dec.	Havre, Mont.	80.0	WNW	9,380	21	Feb.	Billings, Mont.
West Central [8]	43.8	S	2,080	3	Nov.	Modena, Utah	61.8	WNW	3,330	6	July	Casper, Wyo.	98.4	N	11,120	22	Nov.	Winnemucca, Nev.
Southwest [9]	57.5	NW	2,278	25	Dec.	Roswell, N. Mex.	49.9	WNW	5,000	11	Nov.	Albuquerque, N. Mex.	86.0	NNW	7,120	22	Jan.	Albuquerque, N. Mex.

[1] Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and northern Ohio.
[2] Delaware, Maryland, Virginia, West Virginia, southern Ohio, Kentucky, eastern Tennessee, and North Carolina.
[3] South Carolina, Georgia, Florida, and Alabama.
[4] Michigan, Wisconsin, Minnesota, North Dakota, and South Dakota.
[5] Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri.
[6] Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except extreme west Texas), and western Tennessee.
[7] Montana, Idaho, Washington, and Oregon.
[8] Wyoming, Colorado, Utah, northern Nevada, and northern California.
[9] Southern California, southern Nevada, Arizona, New Mexico, and extreme west Texas.

TABLE 4.—*Monthly mean heights of freezing temperatures (0° C.) during year 1940, from mean monthly values based on Airplane and Radiosonde observations*

Stations	Elevation in meters (m. s. l.)	January		February		March		April		May		June		July		August		September		October		November		December	
		Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)	Number of observations	Altitude in hundreds of meters (m. s. l.)
Albuquerque, N. Mex	1,620	31	21	29	24	30	32	30	35	30	42	29	48	13	49										
Anchorage, Alaska	41																			27	11	30	(1)		(5)
Atlanta, Ga	300	31	(1)	29	22	31	28	30	33	31	36	29	43	10	43										
Atlantic Station No. 1 [2]	2									28	37	30	42	28	45	22	43	23	42	20	32	20	30	26	29
Atlantic Station No. 2 [3]	2									27	32	30	38	25	42	27	44	27	42	26	37	14	31	14	26
Barrow, Alaska	6																	15	1	30	(1)		(5)		(5)
Billings, Mont	1,089	31	(1)	29	(1)	31	20	28	24	29	33	29	41	14	45										
Bismarck, N. Dak	505	31	(1)	29	(1)	31	(1)	30	14	31	30	29	40	13	43	31	44	29	42	31	30	30	(1)	31	(1)
Boise, Idaho	824	31	[4] 10	28	17	31	23	29	26	31	36	29	44	13	47										
Brownsville, Tex	6															27	50	30	49	30	46	26	44	30	39
Buffalo, N. Y	220	29	(1)	29	(1)	31	(1)	28	11	27	25	29	36	12	32										
Charleston, S. C	14	31	13	29	26	31	31	28	34	31	38	30	45	13	45	29	49	30	45	31	37	30	38	30	33
Dayton, Ohio	150	22	(1)	24	(1)																				
Denver, Colo	1,616	31	(1)	29	[4] 20	31	27	30	30	31	38	28	46	13	48	29	47	28	45	31	38	30	[4] 25	31	[4] 24
El Paso, Tex	1,193	31	28	29	30	31	34	30	38	29	42	30	48	13	50	20	49	30	47	31	41	30	35	31	33
Ely, Nev	1,908	31	(1)	29	(1)	29	26	30	30	31	40	30	46	13	49	31	48	29	40	30	35	30	(1)	31	(1)
Fairbanks, Alaska	153	30	(1)	28	(1)	31	(1)	29	15	31	18	29	25	13	28										(5)
Great Falls, Mont	1,117															31	43	30	38	31	29	30	(1)	28	[4] 16
Joliet, Ill	178	31	(1)	26	(1)	28	(1)	29	19	28	27	28	38	13	39	26	44	29	38	27	31	30	10	31	(1)
Juneau, Alaska	49	31	2	28	1	31	(1)	29	13	30	14	29	18	12	24					24	13	24	2	30	5
Ketchikan, Alaska	26																			27	17	28	8	21	9
Lakehurst, N. J	39	29	(1)	29	(1)	31	(1)	30	15	31	30	29	39	29	42	30	43	30	35	30	27	30	10	30	14
Medford, Oreg	401	28	22	28	19	31	23	30	23	31	33	29	44	13	44	18	46	29	34	30	31	30	23	31	23
Miami, Fla	4	31	37	29	40	31	41	29	43	30	44	29	46	13	47							28	47	30	40
Minneapolis, Minn	263	31	(1)	29	(1)	31	(1)	29	16	30	26	27	40	12	40										
Nashville, Tenn	180	31	(1)	29	14	23	23	30	30	30	34	29	42	12	43	31	47	30	41	31	37	28	28	31	27
Nome, Alaska	14																			28	(1)	28	(1)		(5)
Norfolk, Va	10	19	(1)	15	12	23	8	27	23	24	31	26	40	25	43	26	43	24	40	22	32	23	25	20	24
Oakland, Calif	2	31	26	29	24	31	29	30	30	31	37	29	44	13	46	31	47	29	40	31	36	29	32	30	29
Oklahoma City, Okla	391	30	(1)	29	22	29	29	28	34	31	39	30	45	13	48	31	47	27	44	28	37	29	30	31	30
Omaha, Nebr	301	31	(1)	29	(1)	31	6	29	25	31	31	30	43	13	45	30	44	29	42	30	35	30	17	31	[4] 17
Pensacola, Fla	24	28	27	28	29	30	34	27	38	31	40	30	44	30	47	22	45	9	42	23	36	21	37	27	34
Phoenix, Ariz	339	31	30	29	29	31	34	30	36	30	43	30	49	13	53	31	51	29	47	30	40	28	35	30	33
Portland, Me	19											30	35	12	32							28	8	31	(1)
St. Louis, Mo	171	31	(1)	29	(1)	31	17	30	27	31	32	30	44	13	45										
San Antonio, Tex	174	31	30	29	33	31	37	30	42	31	43	29	47	12	48										
San Diego, Calif	19	29	32	28	29	28	33	29	35	29	42	26	47	30	47	12	49	11	45	31	42	30	36	28	34
Sault Ste. Marie, Mich	221	31	(1)	29	(1)	31	(1)	30	6	31	22	30	31	13	29	30	37	28	31	31	17	30	(1)	31	(1)
Seattle, Wash	10	22	17	26	14	23	15	24	19	27	28	24	35	20	34	31	39	21	33	27	25	26	16	31	17
Shreveport, La	51	25	5	18	29	17	29																		
Spokane, Wash	508	31	(1)	29	11	31	18	30	21	30	29	29	38	11	42									14	18
Swan Island, W. I	10																	29	50	28	50		(5)	30	48
Washington, D. C	7	27	(1)	28	7	31	6	29	21	31	31	30	40	30	43	18	45	20	37	30	30	29	22	30	23

1 Surface.
2 In or near the 5° square: Lat. 35°00′ N. to 40°00′ N.; long.: 55°00′ W. to 60°00′ W.
3 In or near the 5° square: Prior to Nov. 14, 1940, lat. 40°00′ N. to 45°00′ N., long. 40°00′ W. to 45°00′ W. Subsequent to Nov. 13, 1940, lat. 35°00′ N. to 40°00′ N., long. 45°00′ W. to 50°00′ W.
4 Mean monthly temperature at surface was 0° C. or lower, above which was an inversion with mean temperatures above freezing.
5 Data not yet received.

Airplane observations were received from Pearl Harbor, T. H., throughout the year and from Coco Solo and St. Thomas for several months, but the level of average freezing was not reached at these stations.

RIVER STAGES AND FLOODS

By BENNETT SWENSON

Precipitation during December 1940 was well above normal in the Gulf States and from Missouri, Oklahoma, and Texas, westward to the Pacific coast. Frequent rains, heavy at times, in Mississippi and eastern Texas resulted in protracted high-river stages and moderate flooding. In eastern Texas this was the second consecutive month with abnormally heavy precipitation and flooding. In California, although the first half of the month was dry, excessive rainfall during the latter half brought the state average to 9 inches, nearly 2½ times the normal and the greatest for this month since 1894.

Atlantic slope drainage.—Moderate to heavy rains for 4 days, beginning with December 26, over the upper Susquehanna Basin, caused rising stages with some slight flooding in this area.

East Gulf of Mexico drainage.—Frequent rains over the Pearl River basin during the month, being heavy from the 12th to the 16th, resulted in flood stages beginning on the 16th and continuing into the next month. There were two principal rises; Jackson, Miss., cresting at 24.4 feet on the 23d and at 25.2 feet on the 29th, while Pearl River, La., reached a stage of 15.0 feet on the 21st and after subsiding slightly the stages again rose near the end of the month.

Red Basin.—The Sulphur River was in flood at the beginning of the mouth, the crest of the rise being 27.4 feet on November 29 at Naples, Tex. Two other rises occurred during December and stages of 27.1 and 27.4 feet were reached on December 20 and January 1, respectively. Losses have been estimated at $6,000.

West Gulf of Mexico drainage.—Following moderate to heavy floods in eastern Texas during November (see previous issue of REVIEW) flood stages, or high stages again prevailed during December. These were due to frequent rains, heavy at times, during the month.

At Dallas, the Trinity River exceeded flood stage on three separate occasions during November and December. However, levees protected the city and since there were no growing crops at this time of the year the property loss was slight. The three crests at Dallas were as follows: 32.4 feet on November 26, 33.5 feet on December 16, and 33.2 feet on December 28.

There were two overflows at Trinidad, Tex., the first one extending from November 24 to December 25, with a crest stage of 35.6 feet on November 27, and the second

extending from December 17 to the second week in January with a crest stage of 36.5 feet on December 24. No losses have been reported in this area and property (mostly livestock) valued at $11,000 was protected by removal to higher ground.

Heavy rains over the upper watershed of the Guadalupe River from December 12 to 15 resulted in moderate flood conditions from Gonzales, Tex., to below Victoria, Tex., from the 13th to the 23d. There was no known damage and property (mostly livestock) valued at $5,000 was saved by warnings.

Sacramento Basin.—Following a dry period during November and the first half of December, the latter half of December brought excessive precipitation to the Central Valley of California. High stages resulted in most of the streams of the Sacramento system.

At Fresno, Calif., in the San Joaquin watershed, the total rainfall (5.35 inches), all of which fell in the latter half of the month, was the greatest December total of record. Despite the heavy amounts of precipitation which were concentrated during this period over the basin, the stages in the San Joaquin were high but did not reach flood stage because of the even distribution of run-off.

The official in charge, Sacramento, Calif., reports as follows relative to flood conditions in the Sacramento River:

During November and the first half of December there was one of the longest rainless periods of record for the season. On December 17, however, began a series of storms, recurring at frequent intervals during the remainder of the month. During this period recurring flood waves developed over the upper Sacramento Valley. The first one, occurring on the 18th, was of moderate intensity, but it filled the river channels and covered some bypass lands in advance of the main flood conditions which began to form on the 23d.

Remarkably heavy rainfall amounts were reported over the northern Sacramento River drainage area on the morning of the 18th, the 24-hour amounts at Kennett and Vollmers, in the canyon of the Sacramento River, being 5.70 and 8.10 inches, respectively. With incessant rains continuing, river stages in the Sacramento River during the next several days steadily increased until the actual flood stage of 23 feet at Red Bluff, Calif., was exceeded on December 24, with a crest of 24.8 feet. Timely warnings were issued well in advance of the first major rise and it is believed was an important factor in preventing losses to stockmen and others having property in the low lands in Tehama County and along the river southward throughout all the areas subject to overflow.

On the morning of the 25th, the river at Knights Landing, Calif., aided by a moderate rise in the Feather River, had reached the danger stage of 30 feet, whence it continued to rise to a crest of 31.4 feet on the 28th. In that vicinity the Fremont Weir began to discharge heavily into Yolo bypass on the 25th, reaching a maximum overflow depth of 3.7 feet on the 28th. As a result of this overflow, together with heavy local drainage, particularly that of Cache and Putah Creeks, the flooding of the so-called tidal reclamation districts in the Yolo bypass occurred. These were: Little Holland tract, comprising about 2,700 acres of mostly grain land, flooded late on the evening of the 25th; Prospect Island, containing about 2,500 acres, flooded on the morning of the 26th; and Liberty Island with about 5,000 acres, inundated early a. m. on the 27th. The Lisbon river gage in the Yolo bypass read 17.5 feet at 7 a. m., 26th, and at 4 p. m. it was 18.0 feet. The Liberty Island gage was 14.2 feet at 1 a. m., 27th.

Additional excessive rains occurred during the night of the 26th–27th, causing a secondary rise to begin in the upper courses of the Sacramento River and its tributaries. This rise was more pronounced in the Feather-Yuba and American Rivers, which streams, especially the latter, began to rise rapidly for the first time this season. In the upper Sacramento River the crest at Red Bluff was 23.9 feet on the 27th. By 5 p. m. of the 27th, the rapidly rising American River necessitated the closing of the gates to the flood-control levee on Highway 40 at North Sacramento.

Shortly after midnight of the 27th–28th, 3 of the 48 gates of the Sacramento Weir broke loose, permitting a flow of about 4,500 second feet into the Sacramento bypass. This additional diversion of water from the main river channel no doubt hastened the cresting of the river at Sacramento, which occurred at 4 a. m., December 28, with a stage of 27.27 feet.

At Sacramento the total rainfall during the 15-day period, December 16–30, totaled 9.40 inches, which amount not only constitutes the greatest 15-day total of record for the station, but also is the greatest rainfall for any entire month of December since 1884; likewise it is the greatest monthly amount for all months of the year back to 1911. The total rainfall at Kennett for the 15-day period was 31.77 inches.

As the water was safely confined to the channels in the leveed sections along the river, the flooded areas in the valley were limited to the lowlands that are normally subject to overflow at moderate to high stages. Since these lands were not planted to crops at this season of the year, the damage caused by overflow was comparatively small. Livestock had been removed from affected areas to higher ground.

Heavier losses, however, were sustained in the Yolo bypass from the flooding of Little Holland tract, and particularly Prospect and Liberty Islands, which are more intensely cultivated; also considerable damage was caused to the levees of these islands.

The aggregate money losses occasioned by the flood have been estimated at $178,500, of which $135,000 constituted the prospective crop loss.

A mild flood occurred in the Eel River on the 24th–25th. The crest stage at Fernbridge, Calif., has been estimated at 19 feet. Losses from this flood amounting to $23,000 have been reported.

FLOOD-STAGE REPORT FOR DECEMBER 1940

[All dates in December unless otherwise specified]

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE	*Feet*			*Feet*	
Tioughnioga: Whitney Point, N. Y.	12	28	31	13.9	28
Chenango:					
Sherburne, N. Y.	8	28	31	8.9	29
Greene, N. Y.	8	29	31	9.6	30
Susquehanna:					
Oneonta, N. Y.	12	29	[1]	14.4	30
Bainbridge, N. Y.	12	30	31	12.4	30
Vestal, N. Y.	14	29	[1]	17.45	30
James: Columbia, Va.	10	29	[1]	12.5	30
Saluda: Pelzer, S. C.	6	29	29	6.0	29
Santee: Rimini, S. C.	12	28	30	12.8	29
EAST GULF OF MEXICO DRAINAGE					
Bogue Chitto: Franklinton, La.	11	17	17	11.2	17
Pearl:					
Jackson, Miss.	18	15	[1]	24.4 25.2	23 29
Monticello, Miss.	15	16 27	20 [1]	16.6 18.2	17 28
Columbia, Miss.	17	28	[1]	18.0	30
Pearl River, La.	12	16	[1]	15.0	21
MISSISSIPPI SYSTEM					
Red Basin					
Little: White Cliffs, Ark.	25	18	18	25.9	18
Sulphur:					
Ringo Crossing, Tex.	18	12 26	22 [1]	27.3 27.5	16 27
Naples, Tex.	22	[3] 16 29	6 27 Jan. 6	[3] 27.1 27.4	 20 Jan. 1
Lower Mississippi Basin					
Coldwater: Coldwater, Miss.	13	15	19	13.7	18
WEST GULF OF MEXICO DRAINAGE					
Sabine:					
Logansport, La.	25	[3]	[1]	[4]32.5	1
Bon Wier, Tex.	21	2 30	21 [1]	22.5	14
Orange, Tex.	4	13	22	4.9	17–18
Neches:					
Rockland (near) Tex.	22	[3] 13	6 20	[3] 25.3	 16
Beaumont, Tex.	7	14	22	8.8	17
Elm Fork, Trinity: Carrollton, Tex.	7	16	16	7.6	16
Trinity:					
Dallas, Tex.	28	14 27	18 29	33.5 33.25	16 28
Trinidad, Tex.	28	[3] 17	5 [1]	[3] 36.5	 24
Long Lake, Tex.	40	[3] 27	6 [1]	[3]	
Riverside, Tex.	40	13	13	40.0	13
Liberty, Tex.	24	[3]	[1]	27.1	16, 17, 18

See footnotes at end of table.

FLOOD-STAGE REPORT FOR DECEMBER 1940—Continued

River and station	Flood stage	Above flood stages—dates From—	Above flood stages—dates To—	Crest Stage	Crest Date
	Feet			*Feet*	
Brazos:					
Hempstead, Tex	40	(2)	2	44.1	Nov. 30
Richmond, Tex	35	(2)	4	(3)	
Guadalupe:					
Gonzales, Tex	20	13	14	22.2	13
		16	18	29.0	17
Victoria, Tex	21	14	22	27.4	21
PACIFIC SLOPE DRAINAGE					
Eel: Fernbridge, Calif	18	24	25	19.0	24
Sacramento Basin					
Sacramento: Red Bluff, Calif	23	24	24	24.8	24
		27	27	23.9	27
Knight's Landing, Calif	30	25	31	31.4	28
Columbia Basin					
Long Tom: Monroe, Oreg	10	21	25	11.7	23
		27	30	11.3	29

[1] Continued at end of month.
[2] Continued from preceding month.
[3] Crest occurred previous month.
[4] Highest stage during the month.

WEATHER ON THE NORTH ATLANTIC OCEAN

By H. C. HUNTER

Atmospheric pressure.—For most of the portion of the North Atlantic Ocean that is covered by reports received the pressure during December 1940 averaged higher than normal. This was notably the case for the southeastern part, where the land station at Lisbon, Portugal, shows departure of 8.1 millibars (0.24 inch). For nearly all of the southwestern part, however, particularly the northern Gulf of Mexico, pressure averaged less than normal.

The first half of the month was marked by somewhat higher pressure than the second half over substantially all the North Altantic areas studied.

The pressure extremes found in available vessel reports were 1043.7 and 984.1 millibars (30.82 and 29.06 inches). The high mark was noted during the forenoon of the 5th by the Portuguese steamship *San Miguel*, near 38° N., 35° W. In a not very distant part of the ocean, 39° N., 45° W., the lowest reading was taken at 2 p. m. of the 26th on the U. S. S. *Tuscaloosa*. The latter reading was unusually low for this portion of the North Atlantic, which is not remote from the normal location of the Azores HIGH.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, December 1940*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Millibars	*Millibars*	*Millibars*		*Millibars*	
Lisbon, Portugal	1,027.7	+8.1	1,035	5, 28	1,010	21
Horta, Azores	1,022.3	+1.6	1,041	5	1,000	25
Belle Isle, Newfoundland	1,007.5	+0.4	1,030	5	989	2
Halifax, Nova Scotia	1,017.6	+3.4	1,035	19	1,001	29
Nantucket	1,019.0	+1.4	1,037	19	998	29
Hatteras	1,020.3	0.0	1,033	18	999	29
Turks Island	1,016.5	−0.4	1,020	18, 19	1,011	26, 27
Key West	1,016.3	−2.3	1,025	4	1,000	26
New Orleans	1,017.6	−2.7	1,030	17	989	26

NOTE.—All data based on available observations, departures compiled from best available normals related to time of observation, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.

A few hours after the *Tuscaloosa's* reading, during the early evening of the 26th, pressure readings which similarly were very low for a winter month and for the region of occurrence were noted over the northwestern Gulf of Mexico, the lowest of these vessel readings at hand being 989.2 millibars (29.21 inches) from the American S. S. *Arizona*, when about 60 miles to southward of the southeast coast of Louisiana.

Cyclones and gales.—The reports that have arrived fail to indicate any important storm over the North Atlantic during the first fortnight. While the remainder of the month was somewhat more turbulent, yet it apparently was less so than December usually is.

The main North Atlantic has furnished six reports of whole gales encountered by vessels, as shown in the accompanying table, and two other reports have come from Gulf of Mexico waters.

A well-developed LOW system, extending far from north to south, moved eastward from North America onto the Atlantic during the 20th and 21st. During the 22d and the early hours of the 23d the southern part of the system was sharply developed, and near the 40th parallel, as it advanced from about 60° to 43° west longitude it caused force 10 winds, as reported by the Coast Guard cutters *Champlain* and *Bibb* and a force 9 wind, as reported by the cutter *Spencer*.

The morning of the 26th found a strong LOW near the northeast coast of Texas, whence it advanced eastward and northeastward to Georgia and then northward. Unusually strong winds resulted over much of the Gulf of Mexico; the American M. S. *J. A. Moffett, Jr.*, in the extreme western part of the gulf and the American S. S. *Agwistar*, hove to off Progreso, had whole gales during the 26th or 27th.

A press dispatch states that in the town of Becujal, western Cuba, "10 persons were killed and 150 injured by freakish gale winds." It seems possible that this havoc resulted from a tornado within the southeast quadrant of the low-pressure area. Another report is to the effect that in the state of Vera Cruz, Mexico, there were 9 dead and many injured, because of high winds, presumably of the general circulation connected with the LOW and the marked HIGH which followed it.

Fog.—Over most North Atlantic waters, as far as reports indicate, fog was once more of very rare occurrence during the first half of the month, but somewhat more frequent from the 16th onward, notably during the final 8 days. While more was reported than during the preceding month, especially from the northwestern Gulf of Mexico and waters to eastward of the Middle Atlantic and New England States, yet there are few areas where there seems to have been more fogginess than in an average December.

The 5°-square, 40° to 45° N., 70° to 75° W., furnished reports of fog on 7 days, the greatest number indicated by any square. Two squares adjoining it had fog on 5 days each, as did also one square in the northwestern Gulf of Mexico, namely 25° to 30° N., 90° to 95° W.

No report has come of fog occurring anywhere to eastward of the 50th meridian.

Several accidents near New York resulted from foggy weather. On the 12th the steamers *Berkshire* and *Charles L. O'Connor* collided outside Sandy Hook, but each, though damaged, was able to make port unassisted. On the 29th a less serious collision in East River and a grounding in the harbor were blamed on fog.

OCEAN GALES AND STORMS, DECEMBER 1940

Vessel	Voyage From—	Voyage To—	Position at time of lowest barometer: Latitude	Position at time of lowest barometer: Longitude	Gale began, December	Time of lowest barometer, December	Gale ended, December	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Direction and highest force of wind	Shifts of wind near time of lowest barometer
			° ′	° ′				Millibars					
North Atlantic Ocean													
Uruguay, Am. S. S.	New York	Rio de Janeiro	34 42 N.	66 30 W.	[1] 30	10p, 1	2	1,009.1	S	SW, 8	SW	SW, 8	S-WSW.
Birmingham City, Am. S. S.	Cristobal	Boston	10 10 N.	79 05 W.	11	4a, 11	14	1,007.5	ENE	NE, 7	E	NE, 8	
Duane, U. S. C. G.	On Station No.1		38 30 N.	59 18 W.	14	2a, 14	14	1,020.3		WSW, 8		WSW, 8	SW-NNE.
Champlain, U. S. C. G.	On Station No.2		38 42 N.	47 24 W.	16	4p, 16	17	1,020.7	NW	WSW, 4	NW	NW, 9	WSW-NW.
Excambion, Am. S. S.	Lisbon	Bermuda	36 48 N.	38 06 W.	17	4a, 17	17	1,012.2	NNW	WNW, 6	NNW	NNW, 8	WSW-NW.
Duane, U. S. C. G.	On Station No.1		38 54 N.	59 00 W.	17	8p, 17	18	1,004.4	SSW	WSW, 9	NNW	WSW, 9	SW-NW.
Champlain, U. S. C. G.	Station No. 2	New York	30 18 N.	59 00 W.	22	3a, 22	22	992.6	NW	NW, 9	NW	NW, 10	SW-N.
Spencer, U. S. C. G.	On Station No.1		38 35 N.	59 12 W.	22	4a, 22	22	989.2	NNW	SW, 7	NW	NNW, 9	SW-NW.
Bibb, U. S. C. G.	On Station No.2		38 06 N.	46 06 W.	22	7p, 22	23	988.8	SSE	SW, 9	W	SSE, 10	SSW-SSE-SW.
Spencer, U. S. C. G.	On Station No.1		38 20 N.	59 25 W.	23	4p, 23	26	998.3	W	W, 8	NW	NW, 9	W-NW.
El Mundo, Am. S. S.	Galveston	New York	27 18 N.	79 48 W.	24	7p, 23	25	1,006.1	E	E, 5	SE	E, 10	
New York, Am. S. S.	New York	Port Arthur	28 36 N.	79 00 W.	23	5a, 24	24	1,007.1	E	E, 8	E	E, 8	None.
Bibb, U. S. C. G.	On Station No.2		38 36 N.	47 00 W.	23	6a, 24	24	988.2	S	WSW, 7	NW	SSE, 10	SW-NW.
Gulfcrest, Am. M. S.	New York	New Orleans	32 48 N.	76 00 W.	25	7p, 25	25	1,007.1		SSE, 7		E, 8	E-SSE.
Steel Worker, Am. S. S.	do	Cristobal	34 35 N.	74 05 W.	25	4a, 26	26	1,006.4	SE	SE, 2	SE	SE, 10	SE-S.
John Worthington, Am. S. S.	Baytown, Tex.	Aruba	25 46 N.	90 29 W.	26	12m, 26	28	993.6	WSW	NW, 5	SW	SW, 8	N-SW.
Tuscaloosa, U. S. S.	Norfolk	Lisbon	39 16 N.	45 08 W.	27	2p, 26	27	984.1		NW, 5		SW, 8	NW-W.
Seatrain Havana, Am. S. S.	New Orleans	Havana	26 15 N.	86 00 W.	26	2p, 26	26	991.9	SSE	SE, 5	SSW	SW, 8	SE-SW.
Calamares, Am. S. S.	Pto. Barrios	New York	15 41 N.	88 37 W.	26	4p, 26	28	998.0	SW	SSW	W	S, 8	SW-S.
J. A. Moffett, Jr., Am. M. S.	Philadelphia	Corpus Christi	27 24 N.	96 12 W.	26	4p, 26	27	990.9	WNW	WNW, 8	NW	NW, 10	WNW-NW.
Gulfgem, Am. S. S.	Port Arthur	Providence	25 10 N.	85 10 W.	26	5p, 26	26	992.6		SSW, 8	SW	S, 8	SE-SW.
Bibb, U. S. C. G.	On Station No.2		38 12 N.	46 48 W.	26	6p, 26	27	988.5	NW	NW, 9	NW	NW, 10	W-NW-WNW.
Marques de Comillas, Span. S. S.	Lisbon	Havana	38 00 N.	43 30 W.	27	9p, 26	27	999.9		NW, 7		WNW, 9	W-NW.
Agwistar, Am. S. S.	Hove to off Progreso.		21 30 N.	89 49 W.	27	3p, 27	28	1,002.7	SW	WSW, 10.	W	WSW, 10.	WSW-W.
Massachusetts, Am. S. S.	New York	Pilottown, La.	28 42 N.	87 48 W.	26	5p, 27	27	992.9	SE	W, 5	W	SW, 8	SW-NW.
Monterey, Am. S. S.	Havana	Vera Cruz	22 48 N.	84 24 W.	27	1a, 28	28	1,003.4		SW, 9	WNW	SW, 9	
R. P. Resor, Am. S. S.	Boston	Galveston	30 55 N.	76 10 W.	28	2p, 28	29	1,001.7	SW	SSE, 6	WSW	SW, 8	SW-SSE-SW.
North Pacific Ocean													
Washington, Am. S. S.	Manila	San Francisco	44 24 N.	176 00 E.	[1] 30	11p, 2	3	977.3	SE	WSW, 11	WNW	WSW, 11	WSW-W.
City of Norfolk, Am. S. S.	Yokohama	do	43 23 N.	139 00 W.	1	1a, 2	2	998.0	S	SSW, 9	W	SSW, 9	S-W.
Vermar, Am. S. S.	Balboa	Los Angeles	14 36 N.	94 54 W.	2	3a, 2	2	1,008.1	NNE	NNE, 8	NNE	NNE, 9	None.
Aurora, Am. M. S.	Los Angeles	Vladivostok	[2] 35 33 N.	178 02 E.	4	8p, 4	5	[3] 1,001.7	SSW	SW, 7	NW	W, 10	S-W.
Nebraskan, Am. S. S.	Balboa	Los Angeles	[2] 15 19 N.	93 23 W.	5	4a, 5	5	1,010.8	N	Var., 1	NE	NNE, 8	WNW-NNW.
U. S. S. Arctic	Honolulu	San Diego	25 12 N.	147 48 W.	7	3a, 7	7	1,015.9	NNW	NW, 8	NNW	NNW, 9	SSE-NNW.
Aurora, Am. M. S.	Los Angeles	Vladivostok	30 14 N.	164 50 E.	9	6p, 9	10	[3] 988.8	SE	SW, 8	W	W, 10	S-W.
Collingsworth, Am. S. S.	Yokohama	Seattle	43 46 N.	156 43 E.	12	2p, 14	14	979.3	SE	E, 5	ENE	W, 12	SSE-ENE.
Aurora, Am. M. S.	Los Angeles	Vladivostok	41 02 N.	152 36 E.	13	1p, 13	14	[3] 989.8	E	W, 11	NW	W, 11	E-WSW-W.
Toa Maru, Jap. M. S.	do	Simotu	34 18 N.	166 48 W.	13	1a, 13	15	999.9	W	W, 7	W	W, 9	
Arimasan Maru, Jap. M. S.	Uno	Los Angeles	41 18 N.	142 36 W.	13	4p, 14	15	973.9	ESE	E, 8	SW	ESE, 10	E-ESE.
Manukai, Am. S. S.	San Francisco	Honolulu	32 06 N.	138 48 W.	14	5p, 14	15	990.5	SE	SSW, 7	WSW	SSE, 9	SW-S-WSW.
Kiyo Maru, Jap. M. S.	Yokohama	Los Angeles	42 00 N.	137 36 W.	13	3a, 16	15	979.5	ESE	SE, 5	ESE	E, 9	ESE-SSW.
Maliko, Am. S. S.	Honolulu	San Francisco	28 30 N.	145 36 W.	15	2p, 15	16	1,001.4	WNW	WSW, 6	WNW	NW, 10	SW-WNW.
Sundance, Am. S. S.	Bintang, N.E.I.	Honolulu	16 48 N.	158 24 E.	14	3p, 15	16	1,005.4	NE	NE, 7	ENE	NE, 8	None.
Malama, Am. S. S.	Port Angeles, Wash.	do	[2] 32 44 N.	144 39 W.	15	8p, 15	17	989.8	WSW	W, 9	WSW	W, 9	WSW-W.
U. S. S. Bridge	San Francisco	do	32 54 N.	130 30 W.	14	3p, 15	17	995.9	S	SW, 7	WSW	W, 10	S-SW-SSW.
Manukai, Am. S. S.	do	do	30 42 N.	140 54 W.	15	4p, 15	16	995.3	SW	SW, 7	W	W, 10	W-SW-WSW.
Victor H. Kelly, Am. S. S.	Astoria, Oreg.	Oleum, Calif.	42 42 N.	124 42 W.	16	7a, 17	18	[3] 987.5	ESE	SSE, 9	S	SSW, 9	SE-SSW.
Malama, Am. S. S.	Port Angeles, Wash.	Honolulu	28 24 N.	148 36 W.	18	2a, 18	18	[3] 1,005.1	SW	S, 6	SW	SW, 9	S-SW.
Collingsworth, Am. S. S.	Yokohama	Seattle	47 10 N.	175 20 E.	17	6a, 18	18	[3] 998.0	NE	NE, 8	NE	NE, 9	
Syoyo Maru, Jap. S. S.	do	San Francisco	[2] 41 22 N.	140 46 W.	18	4p, 18	19	[3] 963.4	SE	S, 8	SW	S, 10	SE-SSW.
Huguenot, Am. S. S.	Seattle	Los Angeles	47 40 N.	124 45 W.	17	8p, 17	19	[3] 991.9	SSE	SSE, 8	SSE	SSE, 10	ESE-SSE.
Don Jose, Phil. S. S.	Manila	Portland, Oreg.	48 36 N.	157 24 W.	18	2p, 18	20	[3] 967.8		NW, 7	W	WNW, 9	NNW-WNW.
San Diego Maru, Jap. M. S.	Simotu	San Francisco	41 30 N.	141 30 W.	18	2p, 18	19	[3] 965.1	SE	S, 7	SW	SSW, 9	SE-SSW.
U. S. A. T. Republic	San Francisco	Honolulu	31 15 N.	137 15 W.	20	3p, 20	20	[3] 1,003.1	S	S, 9	W	W, 9	S-W.
Makaweli, Am. S. S.	do	do	35 36 N.	129 24 W.	20	3a, 21	21	[3] 997.6	SE	S, 8	W	SE, 9	SE-SW.
U. S. A. T. Liberty	Honolulu	Seattle	44 00 N.	131 30 W.	21	8a, 24	23	969.5	SE	SSW, 5	WSW	SE, 11	W-SSW.
West Cusseta, Am. M. S.	Gingoog Bay, P. I.	Los Angeles	39 36 N.	168 48 W.	21	4a, 21	23	[3] 988.8	W	W, 8	W	W, 11	S-W.
Syoyo Maru, Jap. S. S.	Yokohama	San Francisco	30 18 N.	127 12 W.	21	10a, 21	21	[3] 986.1	SSE	SSE, 10	SW	SSE, 10	SSE-WSW.
Hawaiian Standard, Am. M. S.	Aberdeen, Wash.	Richmond, Calif.	41 00 N.	124 35 W.	21	2p, 21	21	[3] 983.7	SE	S, 11	SW	S, 11	SE-SW.
Huguenot, Am. S. S.	Portland, Oreg.	Los Angeles	42 46 N.	125 08 W.	21	3p, 21	21	989.8	SSE	SSE, 11	SW	SSE, 11	SSE-S.
Swiftsure Bank, U. S. Lightship.	On station		48 33 N.	125 00 W.	21	12p, 21	22	985.1	SE	E, 12	SW	SE, 12	E-S.
Hawaiian Standard, Am. M. S.	Aberdeen, Wash.	Richmond, Calif.	38 36 N.	123 39 W.	22	12p, 22	22	[3] 982.2	ESE	SE, 5	SE	SE, 9	SE-SW.
Huguenot, Am. S. S.	Portland, Oreg.	Los Angeles	39 15 N.	124 20 W.	22	12p, 22	24	[3] 993.2	SE	S, 6	SSE	SSE, 10	SE-SSW.
Makaweli, Am. S. S.	San Francisco	Honolulu	34 24 N.	132 48 W.	22	9a, 22	24	[3] 994.6	SSE	SSE, 10	W	WSW, 10	SE-WSW.
Kiyokawa Maru, Jap. M. S.	Yokohama	San Francisco	44 06 N.	141 30 W.	22	2a, 23	24	[3] 963.8	E	N, 4	SW	SW, 8	N-NW.
Vermar, Am. S. S.	Seattle	Newport, Oreg.	45 48 N.	124 06 W.	22	6a, 24	25	[3] 977.0	NE	SSE, 8	S	ESE, 9	ESE-S.
Collingsworth, Am. S. S.	Yokohama	Seattle	48 48 N.	156 09 W.	21	8p, 21	25	[3] 967.2	SE	SE, 7	NE	NNE, 10	ESE-SSE.
Kansai Maru, Jap. M. S.	do	San Francisco	45 36 N.	145 30 W.	24	2p, 23	24	962.5	WSW	NW, 6	WSW	WSW, 8	NE-NW-NNW.
Kohala, Am. S. S.	Port Townsend, Wash.	Honolulu	36 24 N.	135 18 W.	22	3p, 23	24	[3] 982.7	SSE	WSW, 8	SW	W, 9	SW-W.
Manoa, Am. S. S.	San Francisco	do	[2] 33 16 N.	126 53 W.	23	6p, 23	24	[3] 1,005.4	WSW	SSW, 7	WSW	W, 10	SSW-S-WSW.
Mauna Kea, Am. S. S.	Portland, Oreg.	do	44 50 N.	127 45 W.	23	2a, 24	25	[3] 967.5	SSE	S, 10	SSW	S, 10	SSE-SW.
Mauna Ala, Am. S. S.	Seattle	do	45 57 N.	130 00 W.	22	3a, 24	25	[3] 965.1	E	E, 2	WSW	WSW, 9	ENE-E-W.
President Cleveland, Am. S. S.	Honolulu	San Francisco	27 48 N.	146 42 W.	25	3p, 25	25	1,010.2	NNW	NW, 9	NW	NW, 9	NNW-NW.
Hawaiian Standard, Am. M. S.	Richmond, Calif.	Eureka	40 48 N.	124 18 W.	26	12 p, 26	26	[3] 1,001.0	SE	ESE, 9	WSW	ESE, 9	ESE-WSW.
Manoa, Am. S. S.	San Francisco	Honolulu	28 12 N.	137 12 W.	27	3a, 27	27	[3] 1,013.9	NE	NW, 3	NNW	NE, 9	NW-NE.
President Cleveland, Am. S. S.	Honolulu	San Francisco	[2] 34 50 N.	131 44 W.	27	3a, 28	29	[3] 992.2	NE	NE, 10	NE	NE, 10	NNE-NE.
Maunalei, Am. S. S.	do	do	34 18 N.	133 18 W.	27	4a, 28	28	[3] 992.9	NE	N, 10	N	N, 10	
West Cusseta, Am. M. S.	Gingoog Bay, P. I.	Los Angeles	37 18 N.	132 00 W.	27	4p, 28	28	[3] 1,005.4	N	NNE, 8	NNE	N, 9	None.
U. S. S. Kanawha	San Diego	Pearl Harbor	30 30 N.	125 30 W.	28	12p, 28	29	988.2	SSW	NW, 9	NNW	NNW, 9	SSW-NNW.
U. S. A. T. Meigs	Manila	San Francisco	35 06 N.	159 30 E.	30	10p, 29	30	[3] 1,003.7	WNW	W, 7	WNW	WNW, 9	W-NNW.
California Standard, Pan. M. S.	Yokohama	do	42 53 N.	169 04 E.	30	7a, 30	31	979.7	SSE	SSE, 9	WNW	SSE, 11	SSE-W.

[1] November. [2] Position approximate. [3] Barometer uncorrected.

WEATHER ON THE NORTH PACIFIC OCEAN

By Willis E. Hurd

Atmospheric pressure.—During much of December a more or less continual series of depressions, many of them of great depth, crossed the northern waters of the Pacific, the most of their centers in passage running a little south of the Aleutian Islands. The average center of these LOWS, so far as daily barometer values indicate, was near the eastern Aleutians. At Dutch Harbor the average pressure for the month was 992.2 millibars (29.3 inches), which is 8.8 millibars (0.26 inch) below the December normal. Pressure was abnormally low over probably all the eastern part of the ocean. Even at San Francisco with an average of 1,013.5 millibars (29.93 inches), the departure from normal was as great as -6. 5 millibars (0.19 inch).

The lowest barometer reported for the month was 962.5 millibars (28.42 inches) read on the Japanese M. S. *Kansai Maru* on the 23d, in 45°36′ N., 45°30′ W.

Consequent upon the considerable cyclonic activity which overspread the eastern as well as the northern waters of the Pacific, the anticyclone usually existing west of California retreated to the westward and lay as a rather narrow belt extending from near Midway Island to the China coast. In lower Japanese waters abnormally high pressure prevailed. At Naha the month's average barometer, 1,020.5 millibars (30.14 inches), was 5.3 millibars (0.16 inch) above the December normal.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressure at sea level, North Pacific Ocean, December 1940, at selected stations*

Stations	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Millibars	*Millibars*	*Millibars*		*Millibars*	
Barrow	1,010.1	−6.6	1,034	15	993	4, 27
Dutch Harbor	992.2	−8.8	1,017	28	972	23
St. Paul	997.7	−4.0	1,023	14	982	26
Kodiak	995.8	−5.2	1,012	9	969	17
Juneau	1,004.7	−4.1	1,035	10	985	22
Tatoosh Island	1,011.2	−3.4	1,032	9	979	24
San Francisco	1,013.5	−6.5	1,025	1	993	24
Mazatlan [1]	1,012.7	−0.8	1,015	4,17,19,21	1,008	26
Honolulu	1,014.2	−2.1	1,019	26	1,006	14
Midway Island	1,018.6	+2.3	1,029	24	1,003	20
Guam	1,010.5	−1.0	1,020	23	1,000	8
Manila	1,012.2	+1.0	1,016	18	1,006	5
Hong Kong	1,021.7	------	1,026	29	1,019	15, 22, 24
Naha	1,020.5	+5.3	1,025	28	1,016	16
Titijima	1,017.2	+1.3	1,025	22	1,010	12
Petropavlovsk [2]	1,006.0	+2.9	1,027	12	979	26

[1] For 21 days. [2] For 22 days.

NOTE.—Data based on 1 daily observation only, except those for Juneau, Tatoosh Island, San Francisco, and Honolulu, which are based on 2 observations. Departures are computed from best available normals related to time of observations.

Extratropical cyclones and gales.—December 1940 will long be remembered as an exceptionally stormy month over the eastern part of the North Pacific Ocean. Along the eastern three-fourths of the routes between the Hawaiian Islands and the coast of the United States, rough weather and fresh to whole gales were of almost daily occurrence from the 14th to the 28th. Along the coast itself from mid-California northward to Vancouver, sea and air combined, over the latter part of the period, to create a condition of general storminess unequaled in previous recent years.

Along the upper western steamer routes, reports of gales, while far less frequent, indicate that winds of high intensity—force 11 to 12—occurred on at least 4 days, the 2d, 13th, 14th, and 30th, resulting in some delays and minor damages to shipping. It was only from middle longitudes of the ocean, between about 160° and 175° W., that reports indicate a condition of much more moderate weather, with only scattered gales of force 8 to 9.

December was notably a month in which a rapid succession of cyclonic disturbances crossed northern waters, and in which a number of other storms formed or reached their height of activity over the ocean's eastern quarter in more middle latitudes. The table of storms and gales, from which it has been necessary to exclude a considerable number of reports of lesser gales, gives a good idea of storm frequency and distribution. Mention may be made of a few of the more important storms.

On December 1 a cyclone was developing east of the Kuril Islands. By the 2d, central near 50° N., and the 180th meridian, it had developed into a deep storm, and on that day the American S. S. *Washington* encountered a westerly gale of force 11, barometer 977.3 millibars (28.86 inches), near 44° N., 176° E. Thereafter the disturbance weakened and, moving rapidly eastward, lay over the upper part of the Gulf of Alaska on the 5th and 6th, no longer affecting the weather along the main-traveled routes.

Two cyclones, one on the 9th and the other on the 12th, left the vicinity of the Kuril Islands and, proceeding eastward, resulted in initiating the stormy weather period to the westward of the United States. The earlier was of considerable depth at the beginning of its oceanic course, one vessel reporting a barometer of 978.9 millibars (28.9 inches), on the 9th, near 43° N., 152° E. Other ships, within a few hundred miles of the center on the late 9th and during the 10th, reported scattered gales of force 8 to 10. By the 13th, following a crossing of middle longitudes unmarked by reported gales, the storm area has expanded to enormous width, extending from near the Peninsula of Alaska almost to the Hawaiian Islands and causing widely scattered gales in southern and eastern quadrants. The highest reported wind was of force 10, encountered near 44° N., 150° W. On the 14th to 16th the center of the wide storm area moved irregularly within the region of about 38° to 47° N., 135° to 150° W., causing widespread gales of force 8 to 10, more particularly along the middle two-thirds of the California-Hawaiian routes. During these days the lowest barometer reported was 973.9 millibars (28.76 inches), read on the Japanese M. S. *Arimasan Maru* near 41° N., 143° W., on the 14th. The southward extent of the storm may be indicated by the report from the American S. S. *Maliko* of a northwest gale of force 10 late on the 15th near 30° N., 140° to 142° W. The eastward extent may be gaged from the report of another vessel on the same date of moderate southwesterly gales and barometer depressed to 995.9 millibars (29.41 inches), near 33° N., 130° W. By the 17th the storm lay off the Oregon coast, and there, in the early morning, in 42°42′ N., 124°42′ W., the American S. S. *Victor H. Kelly* had a southerly gale of force 9, with barometer at 987.5 millibars (29.16 inches).

Meanwhile, the second storm alluded to, that of the 12th near the Kuril Islands, early displayed great energy, for on the 13th, within the region, 40° to 45° N., 152° to 157° E., two American vessels, the *Collingsworth* and the *Aurora*, encountered violent westerly gales (force 11–12) with low barometer. As the storm moved eastward, lesser local gales were reported along its course. By the 18th and 19th a large area of the northeastern part of the ocean from southwestern Alaska to the Washington and Oregon coasts was affected by it. On the 18th west to southwest gales of force 8 to 9 occurred as far south as the 28th parallel, near 148° W., while to the northward,

near 45° N., 140° to 150° W., in the midst of the stormy weather, pressures as low as 965 millibars (28.5 inches) were reported. On the 19th gales of force 9 were observed at various points from near the Alaska Peninsula to the coast of Oregon.

No sooner had this vast storm area receded northward to the Gulf of Alaska, than a secondary LOW appeared near 35° N., 140° W., on the 20th, accompanied by fresh to strong gales in the vicinity. On the 21st the storm center lay at some distance off the north-central coast of California, attended by heavy weather at sea, and by violent gales of force 11 to 12 close in along the coast from northern California to Vancouver Island. At North Head, Wash., the wind attained its maximum velocity of 84 miles from south on that date, while at Tatoosh Island the highest speed, 88 miles from south, occurred on the 22d. On land extensive damage was done by the strong winds, and the accompanying heavy rains and floods, and off the coast several small vessels lost their lumber cargoes and were placed in precarious situations.

The center of this storm entered the British Columbia coast on the 22d, but stormy weather continued in less degree far to the southward, and a new LOW to the westward was further threatening the storm-beaten region. This LOW, central about midway between Washington and the eastern Aleutians on the 22d, spread eastward and southward during the 23d and 24th, accompanied by widespread gales in a broad region over which pressure fell far below 982 millibars (29 inches). While the wind velocities in American coastal waters did not attain the height reached on the 21st and 22d, they were nevertheless strong. Many instances of force 10 gales were reported at sea on the 23d and 24th, and on the latter date the extreme northwest-southeast range over which whole gales were scatteringly reported, was from about 50° N., 155° W., to about 33° N., 127° W. The general wind intensity near the Oregon coast may be indicated by the report of the American S. S. *Mauna Kea*, Portland to Honolulu. This vessel, storm beaten from the 23d to 25th, encountered her highest wind, a south gale of force 10, barometer 967.5 millibars (28. 57 inches), on the early morning of the 24th, near 45° N., 128° W.

During the 25th and 26th, as the storm slowly moved northward, conditions ameliorated in west coast waters, but the seas continued high, and some gales of force 9 continued off the Oregon coast and vicinity. On Christmas Eve, according to newspaper accounts, while the schooner *Stanwood* was in distress off Point Arena, 10 Coast Guardsmen set out to her rescue in motorboats. They became involved in the high seas and poor visibility and were lost to observation. They finally were themselves rescued, some 36 hours later, following a long and arduous search, during which another rescue vessel reached the *Stanwood*.

During the 27th a cyclone developed about midway between the Hawaiian Islands and Lower California. On that day the American S. S. *Manoa* had a northeast gale of force 9 near 28° N., 137° W. The storm deepened on the 28th, and at about 34° to 35° N., 132° to 133° W., both the *President Cleveland* and the *Maunalei* had northerly gales of force 10. On the 29th, as the storm neared the southern coast of California, the U. S. S. *Kanawha*, with a barometer of 988.2 millibars (29.18 inches), experienced a northwesterly gale of force 9 in 30°30′ N., 125°30′ W. During the night of the 29th–30th, the disturbance entered the coast as a mere depression.

The month closed with a storm of the 30th and 31st in northern waters, accompanied on the 30th by winds of force 10 to 11 within the region of about 42° to 48° N., 165° to 175° E., and scattered gales of less force to the southward.

Tropical cyclones.—Subjoined in a report by the Reverend Bernard F. Doucette, Weather Bureau, Manila, P. I., of four typhoons of the month in Far Eastern waters.

Tehuantepecers.—In the Gulf of Tehuantepec northeasterly gales associated with high pressure to the northward, occurred as follows: of force 7 on the 17th, of force 8 on the 5th, and of force 9 on the 2d.

Fog.—Very little fog was encountered far at sea. Ships reported it on 3 days off the Washington and Oregon coasts, on 13 days off the California coast, and on 2 days off the upper coast of Lower California.

TYPHOONS AND DEPRESSIONS OVER THE FAR EAST

By BERNARD F. DOUCETTE, S. J.

[Weather Bureau, Manila, P. I.]

Typhoon, December 2–7, 1940.—This storm appeared to intensify very quickly in a low-pressure area between Yap and Mindanao. It moved west-northwest to a position close to and east of central Samar and then continued on a westerly course across the Visayan Islands into the China Sea. This course was very close to and south of Catbalogan, Samar Province, close to and and north of Capiz, Capiz Province, and within 60 miles of the southern part of Mindora Island. Over the China Sea, it changed its direction to the west-northwest until the afternoon of December 6 when it began moving along a southwesterly course to the region about 100 miles east of southern Indo-china, where it disappeared December 7.

At Barongan, Samar Province, the barometric minimum was 739.87 mm. (986.4 mb.) with southwest winds, force 6. Catbalogan, Samar Province, had 735.83 mm. (978.7 mb.) with north-northeast winds, force 2, at its lowest value. Capiz, Capiz Province, reported 743.92 mm. (991.7 mb.) as the minimum value. The first two stations were under the influence of the typhoon during the early forenoon hours of December 3, while Capiz experienced its share of the typhoon strength during the early evening hours of the same day.

No lives were lost, due to this storm, as far as could be learned from the daily papers, but the damage to roads and bridges due to flooded rivers was considerable.

Typhoon, December 3–13, 1940.—As a depression, this storm moved west-northwest from a position about 300 miles east of Yap, intensifying to typhoon strength, December 5, when it reached the region about 500 miles east of San Bernardino Strait. It moved westerly and then inclined to west-northwest when approaching the archipelago, a change which carried the storm center over the northern part of Catanduanes Island. The progress of the center was checked, December 7 and 8, when it was north of Camarines Norte Province and the center appeared to be recurving to the northeast. However, it did not move very far in this direction and during the night of December 8 to 9 it reversed its course and moved rather rapidly toward the southwest. The center, violent over a small area, passed between Capalonga and Daet, Camarines Norte Province, then over the Bondoc Peninsula and north of Marinduque Island. It continued weakening as it moved, and passed over the central or northern part of Mindoro Island on its way to the China Sea. It moved westerly away from the archipelago and shifted to the southwest 1 day before it disappeared east of southern Indo China, December 13.

The vortex, as it passed over the northern part of Catanduanes Island, affected the weather bureau station at Virac, but full details are not available at the present writing. The lowest pressure value reported as the storm approached the island, was 744 mm. (991.9 mb.) with northwest winds, force 8, December 6, 8 p. m. (Manila time). After the storm reversed its course and was moving southwest, Capalonga had a minimum of 742.00 mm. (989.3 mb.) with winds from the north-northwest, force 12. Daet reported 739.46 mm. (986.0 mb.) with winds from the south-southeast, force 8. These values were recorded between midnight and 1:30 a. m. December 9. Boac, Marinduque Island, had 739.96 mm. (986.6 mb.) with south-southeast winds, force 7, during the early forenoon of the same day.

There were 60 lives lost on Catanduanes Island due to this typhoon. After it reversed its course, 10 laborers lost their lives when a tree fell on their house at Exciban Camp, Labo, Camarines Norte, and three people drowned between Polillo Island and Camarines Norte. There was great property damage due to the winds and the rains, and even more indirect loss, due to failure of power lines, etc., forcing mines and mills to shut down for repairs.

Typhoon, December 8–19, 1940.—This center formed far to the south-southeast of Guam and moved north or north-northwest, passing close to and east of Guam during the early morning hours of December 10. It changed to the west when about 100 miles north-northeast of Guam, moving about 400 miles along this course. Then it changed to the southwest and west-southwest, threatening Samar Island. But its progress was checked and it apparently weakened over the regions about 150 miles east of southern Samar. As a low pressure area it probably reversed its course, moving about 200 miles to the east. After December 19, it was certain that the storm was no longer in existence.

At Guam, a series of observations was made as the typhoon center moved north or north-northwest toward the island, and the lowest value reported was 748.50 mm. (998.50 mb.) with west winds, force 5, as the center passed about 60 miles east of the station (December 10, 4 a. m. Guam time).

During these typhoons, the upper winds were almost the same for each storm, the northeast and east quadrant winds much stronger and more active than the southwest quadrant winds. As these centers approached the Philippines, the east quadrant winds at Zamboanga and Cebu changed to the southwest quadrant, and Cebu winds usually were stronger than those over Zamboanga. Only a few reports were received at the observatory to give an idea of the upper winds over the Netherland East Indies, and that which was most significant was a strong southwest current (i. e. 50 k. p. h., or more) over Batavia, December 12, (Typhoon of December 8–19), which however, did not persist. This one ascent is the only indication throughout the month of any activity in the southwest monsoon current. The typhoon of December 3 to 13, which made a loop about 100 miles east of Manila, was under the influence of a strengthening northeast quadrant current and perhaps the shift to the southwest took place because the southwesterly winds were weak. All of these three typhoons changed their courses from westerly or west-northwesterly, to the southwest, very likely due to weak southwest monsoon winds and strong northeast monsoon winds.

Typhoon, approximately December 18–22, 1940.—There were a few reports from ships, names unknown, December 19 and 20, showing that a typhoon was in existence far to the east or east-northeast of Guam. The storm appeared to be moving northeast or north-northeast toward the regions north of Midway Island. From the information available, the center crossed the date line December 21, but more data will be required to be sure of this. On December 27, the newspapers had a dispatch originating in Honolulu, reporting the death of two men on board the S. S. *Etolin*, which was under the influence of the typhoon, December 20. These two men were injured so seriously that they died before the ship reached Honolulu, December 27.

CLIMATOLOGICAL DATA

[For description of tables and charts, see REVIEW, January, pp. 32 and 38]

CONDENSED CLIMATOLOGICAL SUMMARY OF TEMPERATURE AND PRECIPITATION BY SECTIONS

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	52.0	+4.3	Geneva	80	11	Scottsboro	18	4	6.30	+0.89	Highland Home	11.50	Muscle Shoals	2.62
Arizona	46.8	+4.1	Gila Bend	90	[1]2	Williams	−12	15	3.70	+2.48	Pinal Ranch	10.39	Yuma	.79
Arkansas	46.7	+3.8	Bethesda	77	10	Gilbert	14	[1]2	3.86	−.36	El Dorado	8.60	Clinton	1.50
California	48.5	+2.7	Indio	92	[1]2	2 stations	−15	[1]14	9.16	+5.34	Kennett	31.77	Cow Creek	.30
Colorado	28.3	+2.6	Rocky Ford	75	9	Taylor Park	−33	15	1.11	+.21	Wolf Creek Pass	6.51	Utleyville	T
Florida	64.2	+4.4	Davenport	90	1	Morriston	27	5	5.77	+2.99	West Palm Beach	15.22	La Belle (Engineers)	2.62
Georgia	51.2	+3.4	Alapaha	84	12	2 stations	14	4	4.14	−.08	Summerville	7.37	Tifton	1.83
Idaho	30.1	+3.7	2 stations	64	[1]9	do	−26	[1]13	1.74	−.30	Deception Creek	8.09	Roberts	.12
Illinois	36.1	+5.0	Griggsville	71	9	Freeport	−16	3	2.05	−.07	Anna	4.36	Clinton	.52
Indiana	37.2	+4.9	Vevay	67	26	Wheatfield	−8	3	2.37	−.42	La Porte	3.73	Whiting	1.26
Iowa	28.4	+4.2	Keokuk	68	9	Decorah	−32	3	1.36	+.19	Newton	2.45	Milford	.51
Kansas	36.5	+3.4	Richfield	77	9	St. Francis	−14	14	1.02	+.18	Toronto	2.34	Tribune	.25
Kentucky	42.7	+5.1	Williamsburg	75	24	Lynch (near)	6	[1]3	3.16	−.69	Greenville	5.02	Jenkins	1.04
Louisiana	56.3	+3.8	2 stations	83	12	Plain Dealing	26	16	8.92	+3.55	Bogalusa	16.12	Lake Providence	5.18
Maryland-Delaware	40.3	+5.0	Snow Hill, Md	70	28	Oakland, Md	−13	4	2.48	−.69	State Sanatorium	3.57	Bridgeville, Del	1.49
Michigan	27.8	+2.8	Dawagiac	62	16	2 stations	−25	3	2.16	+.11	Whitefish Point	4.16	St. Ignace	.60
Minnesota	19.2	+3.4	Pipestone	49	23	Meadowlands	−39	13	.75	−.02	Rochester	2.18	Big Falls	.02
Mississippi	52.4	+4.1	Columbia	83	12	Holly Springs	22	2	7.53	+2.23	Perlington	13.44	Rochdale	3.87
Missouri	38.6	+4.4	Mount Vernon	78	9	Unionville	−2	4	2.58	+.43	New Madrid	5.20	Edgerton	1.02
Montana	28.1	+4.7	Billings No. 2	68	8	Wisdom	−31	13	.46	−.50	Heron	3.57	Ovando	.00
Nebraska	30.1	+3.1	3 stations	70	[1]5	Arthur	−31	5	.93	+.25	Western	2.20	Chadron	.10
Nevada	35.2	+4.0	2 stations	80	[1]2	San Jacinto	−14	13	1.70	+.71	Marlette Lake	9.13	McGill	.04
New England	27.0	+.4	Adams, Mass	63	25	Enosburg Falls, Vt	−34	4	3.13	−.20	Somerset, Vt	6.36	Dixville Notch, N. H.	1.77
New Jersey	37.0	+3.2	Hammonton	67	28	Layton	−4	4	3.00	−.55	Newton	5.27	Tuckerton	1.62
New Mexico	37.5	+3.4	Tucumcari No. 2	78	8	2 stations	−26	16	1.14	+.45	Mogollon	5.04	3 stations	.00
New York	29.8	+2.9	Port Jervis	66	25	Stillwater Reservoir	−35	4	3.89	+.96	Trenton Falls	8.49	Letchworth Park	1.78
North Carolina	46.2	+3.6	Moncure	79	13	Jefferson	4	4	3.00	−.79	Warrenton	9.32	Greenville	1.13
North Dakota	19.8	+6.7	3 stations	59	6	Willow City	−36	12	.42	−.07	Milnor	2.09	Fort Yates	T
Ohio	37.5	+5.7	2 stations	68	[1]16	Lima	−2	3	3.00	+.26	Barnesville	4.35	New Carlisle	1.66
Oklahoma	43.1	+3.1	Guymon	79	9	Hooker	4	15	1.83	+.17	Bear Mountain Tower.	6.36	Kenton	.34
Oregon	35.9	+2.3	McKinley	71	21	Sod House	−20	14	3.40	−.42	Bandon	14.64	Lake	.11
Pennsylvania	36.0	+4.6	3 stations	68	[1]16	Mount Pocono	−9	4	3.07	−.01	Mariansville	4.95	Towanda	1.39
South Carolina	49.7	+3.0	Conway	81	13	2 stations	14	4	2.76	−.77	U. S. Fish Hatchery, Oconee County.	7.84	Orangeburg	1.11
South Dakota	27.1	+5.2	2 stations	67	[1]6	Sisseton	−25	13	.39	−.15	Wagner	1.38	2 stations	T
Tennessee	45.4	+4.6	London	74	11	Rugby	8	4	3.31	−1.19	Lock A	5.32	Kingsport	1.42
Texas	51.6	+2.7	2 stations	87	11	Dalhart	8	16	3.86	+1.58	Kirbyville (near)	12.40	2 stations	.00
Utah	29.5	+2.6	Springdale (Lion Park).	71	8	Panguitch	−31	15	1.68	+.59	Timpanagos Summit.	6.62	Callao	T
Virginia	42.7	+4.6	Bedford	74	10	Mountain Lake	−6	4	2.45	−.59	Big Meadows	4.80	Monterey	.74
Washington	35.8	+2.9	Landsburg	68	23	Chesaw	−5	16	4.50	−.91	Quinalt	20.35	Mottinger	.97
West Virginia	40.4	+5.7	Valley Chapel	72	16	Terra Alta	−11	4	2.31	−.96	New Martinsville	4.13	2 stations	1.19
Wisconsin	23.0	+2.4	2 stations	55	[1]24	Blair	−37	3	1.39	+.09	Rest Lake	2.60	Superior	.62
Wyoming	25.4	+3.4	Yoder	74	[1]5	West Yellowstone	−39	14	.56	−.19	Bechler River	4.06	Powell	T
Alaska (November)	18.6	+4.6	3 stations	57	3	Fort Yukon	−32	28	2.79	+.04	Little Port Walter	30.90	2 stations	.05
Hawaii	70.7	+1.1	Kaneohe (Oahu)	90	23	Haleakala (Maui)	34	7	4.15	−4.89	Kakui (Maui)	20.00	Mahukona	.00
Puerto Rico														

[1] Other dates also.

CLIMATOLOGICAL DATA FOR WEATHER BUREAU STATIONS

District and station	Elevation of instruments: Barometer above sea level	Thermometer above ground	Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Temperature of the air: Mean max.+mean min.÷2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Departure from normal	Days with 0.01 inch, or more	Wind: Total movement	Average hourly velocity	Maximum velocity: Miles per hour	Direction	Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							29.6	+1.4										79	2.85	−0.6										6.6		
Eastport	75	67	85	29.97	30.06	+0.08	26.8	+0.5	48	7	36	−4	4	18	35	25	21	80	3.28	−0.5	15	10.5	nw.	29	sw.	7	6	6	19	7.2	10.9	T
Greenville, Maine	1,070	6			28.86	30.08	16.8		39	27	28	−27	4	6	42	15	14		3.22		14											9.0
Portland, Maine [3]	103	82	117	29.95	30.06	+.03	24.4	−3.2	45	8	34	−16	4	14	39	22	20	84	3.11	−.9	12	5.0	n.	17	n.	3	13	6	12	5.8	10.8	T
Concord [1]	289	54	72	29.76	30.09	+.03	27.2	+.4	49	25	36	−11	4	19	38	22	20	85	3.42	+.3	12	4.8	n.	21	nw.	17	8	7	16	6.5	9.8	.4
Burlington	403	11	48	29.63	30.09	+.04	23.5	−.9	42	17	32	−17	4	15	36	22	19	85	2.50	+.6	15	9.8	s.	35	s.	7	3	8	20	7.8	8.2	T
Northfield	876	12	60	29.10	30.09	+.04	21.6	+1.2	45	27	33	−26	4	10	45	17	15	85	2.25	−.2	13	7.0	sw.	27	sw.	7	5	9	17	6.8	9.5	T
Boston	124	33	62		30.09	+.04	34.3	+1.8	58	25	42	2	4	27	30	30		71	2.76	−.7	13	9.8	nw.	34	sw.	10	7	6	18		3.5	.0
Nantucket	12	14	90	30.08	30.09	+.04	38.7	+2.9	55	28	46	14	4	32	26	36	32	79	3.29	−.4	10	12.7	w.	36	sw.	17	5	9	17	7.2	1.0	.0
Block Island	26	11	46	30.07	30.10	+.04	38.5	+2.5	56	28	46	9	4	32	33	36	32	76	3.10	−.7	14	16.1	w.	43	nw.	17	13	5	13	5.5	T	.0
Providence [2]	159	65	25	29.93	30.11	+.05	35.4	+3.8	62	25	43	2	4	28	34	30	25	73	2.15	−1.2	12	10.5	nw.	42	nw.	17	8	7	16	6.5	2.9	.0
Hartford [1]	159	122		29.93	30.11	+.04	32.6	+2.8	56	25	41	3	4	24	39	29	25	78	2.67	−1.3	14	8.0	n.	33	sw.	7	7	8	16	6.5	4.1	.0
New Haven [3]	107	74	68	30.00	30.12	+.05	35.6	+3.1	60	25	43	6	4	28	31	32	28	76	2.46	−1.6	11	8.8	n.	30	sw.	10	9	7	15	6.0	3.2	.0
Middle Atlantic States							39.9	+4.4										76	2.36	−0.9										6.5		
Albany [1]	97	26	40	29.99	30.10	+.02	28.6	+.1	48	25	36	−9	4	21	33	27	23	77	2.64	.0	12	9.3	nw.	34	w.	1	5	7	19	7.5	5.5	T
Binghamton	871	57	79	29.16	30.11	+.02	31.9	+3.7	50	25	40	−5	4	24	32	29	26	82	2.13	−.2	12	6.5	nw.	21	nw.	17	1	10	20	8.0	.6	T
New York	314	415	454	29.76	30.11	+.02	38.9	+3.9	58	25	46	11	4	32	25	35	29	68	2.53	−1.1	11	14.2	nw.	49	nw.	17	10	6	15	6.4	3.8	.0
Harrisburg	374	30	49	29.72	30.14	+.02	37.6	+4.9	60	29	45	11	4	30	33	33	29	76	2.86	−.2	10	6.9	nw.	28	nw.	17	4	10	17	7.2	1.5	.0
Philadelphia [3]	114	174	367	30.00	30.13	+.02	40.4	+4.1	62	29	47	14	4	34	25	35	32	80	2.53	−.9	11	12.3	n.	35	nw.	17	6	10	15	6.4	2.9	.0
Reading	323	47	306	29.78	30.14		38.0	+5.8	61	25	45	12	4	31	31	34	28	70	3.40	−.2	11	10.6	nw.	41	nw.	17	5	9	17	6.8	2.3	.0
Scranton	805	72	104	29.21	30.10	.00	33.7	+3.0	56	25	41	5	4	27	30				2.11	−.9	8	6.5	sw.	21	nw.	17	5	6	20	7.4	1.5	.0
Atlantic City	52	37	172	30.07	30.13	+.03	41.6	+5.2	59	13	48	17	4	35	24	38	33	75	2.53	−1.4	10	14.9	n.	35	w.	17	7	10	14	6.5	.8	.0
Trenton	190	89	107	29.92	30.13		38.3	+3.9	62	29	46	12	4	31	26	34	28	70	3.02	−.3	9	8.3	n.	26	nw.	17	4	12	15	6.6	3.9	.0
Baltimore [2]	123	100	215	30.00	30.14	+.01	43.0	+5.8	62	10	50	18	4	36	26	38	32	69	2.68	−.7	11	9.6	sw.	31	nw.	17	6	12	13	6.6	.2	.0
Washington	112	62	85	30.01	30.14	+.01	42.8	+6.2	63	10	50	16	4	35	29	38	32	68	2.27	−1.0	11	6.3	nw.	34	nw.	17	6	12	13	6.5	T	.0
Cape Henry	18	8	54	30.11	30.13		47.8	+4.1	73	13	55	28	4	41	33	43	40	81	1.10	−2.3	9	12.0	n.	36	n.	17	13	5	13	5.4	.0	.0
Lynchburg	686	144	184	29.40	30.15	+.01	44.0	+4.5	69	10	54	12	4	35	34	38	33	72	3.02	−.2	12	6.8	nw.	27	nw.	5	12	7	12	5.6	.0	.0
Norfolk [2]	91	80	125	30.04	30.14	+.01	48.4	+5.3	72	13	56	23	4	41	31	43	40	82	1.16	−2.2	6	9.9	ne.	25	n.	17	12	6	13	5.6	.0	.0
Richmond [3]	144	11	52	29.98	30.14	.00	44.4	+4.6	65	10	53	16	4	36	32	38	35	83	1.56	−1.7	11	7.6	ne.	21	sw.	7	14	5	12	5.2	T	.0
Wytheville	2,304	49	55	27.69	30.14	−.01	40.1	+4.8	63	12	50	6	4	30	31	35	32	80	2.29	−.6	13	6.8	w.	27	w.	10	10	3	18	6.4	T	.0
South Atlantic States							50.8	+4.1										82	3.04	−0.3										6.1		
Asheville	2,253	89	104	27.75	30.16	.00	43.6	+5.8	67	10	54	18	4	34	36	38	34	76	2.79	−.4	9	8.6	nw.	24	e.	27	8	9	14	6.0	T	.0
Charlotte [2]	779	63	86	29.29	30.13	−.03	47.0	+4.0	70	13	56	19	4	38	29	41	37	80	2.83	−1.0	12	7.2	ne.	21	sw.	29	8	11	12	5.8	.0	.0
Greensboro [1]	886	6	56	29.19	30.15		43.9		68	11	54	13	4	33	39	38	36	84	2.17		12	7.8	ne.	22	nw.	5	8	8	15	6.2	.0	.0
Hatteras	11	5	50	30.12	30.13	.00	52.2	+2.1	72	13	58	33	4	46	27	49	47	87	5.56	+1.4	12	12.8	n.	31	se.	25	8	9	14	5.9	.0	.0
Raleigh [2]	376	103	146	29.73	30.14	−.01	47.2	+4.2	73	13	58	16	4	37	35	42	38	80	1.66	−1.9	10	8.3	ne.	24	sw.	29	11	3	17	6.0	.0	.0
Wilmington	72	73	107	30.06	30.13	−.02	52.6	+3.5	73	12	62	24	4	44	32	47	44	81	2.93	+.2	12	8.1	n.	26	sw.	16	11	7	13	5.5	.0	.0
Charleston [3]	48	11	92	30.06	30.11	−.04	55.0	+3.3	77	13	62	33	4	48	22	47	45	85	2.36	−.4	9	9.9	n.	26	e.	25	9	8	14	5.7	.0	.0
Columbia, S. C.	347	70	91	29.76	30.13	−.03	51.0	+3.8	73	11	60	27	4	42	31	45	41	80	1.32	−1.7	10	8.2	ne.	24	w.	29	8	9	14	6.0	.0	.0
Greenville, S. C.	1,040	70	78	29.00	30.12		47.6	+5.4	68	21	56	23	4	39	28				2.65	−2.2	10	7.1	ne.	26	sw.	29	10	7	14	5.7	.0	.0
Augusta [2]	182	62	77	29.92	30.11	−.05	51.6	+3.5	75	12	61	29	4	42	37	45	41	77	2.41	−.8	11	5.7	ne.	22	sw.	28	7	7	17	6.6	.0	.0
Savannah [2]	65	73	152	30.03	30.10	−.05	57.3	+4.9	77	13	66	35	4	49	30	50	47	83	4.20	+1.3	12	9.6	ne.	43	se.	27	4	13	14	6.7	.0	.0
Jacksonville [2]	43	86	110	30.04	30.08	−.06	61.0	+4.7	78	12	69	36	4	53	29	54	52	88	5.61	+2.6	13	7.6	ne.	23	w.	28	5	6	20	7.2	.0	.0
Florida Peninsula							71.3	+4.0										84	4.45	+2.6										5.3		
Key West [2]	21	10	64	29.99	30.01	−.07	73.8	+.8	84	21	79	60	4	69	16	68	67	84	6.25	+4.6	11	10.6	e.	42	w.	27	13	10	8	4.6	.0	.0
Miami [2]	25	124	168	30.01	30.04	−.07	73.1	+5.1	84	2	78	50	4	70	23	65	63	86	3.97	+2.3	7	9.8	e.	43	s.	27	10	10	11	5.4	.0	.0
Tampa [2]	35	88	197	30.01	30.04	−.08	67.1	+5.0	83	16	75	42	4	59	27	61	58	83	3.12	+1.0	10	11.9	e.	34	s.	28	8	10	13	6.0	.0	.0
East Gulf States							53.7	+3.8										82	6.45	+2.2										6.6		
Atlanta [1]	1,173	5	72	28.85	30.11	−.05	47.6	+2.9	67	11	56	26	4	39	34	43	40	81	4.39		14	9.9	e.	32	s.	13	7	8	16	6.9	.0	.0
Macon [2]	370	79	87	29.70	30.10	−.06	51.0	+3.5	75	12	60	26	4	42	38	46	42	81	4.47	+.5	12	6.6	n.	17	e.	23	7	6	18	6.9	.0	.0
Thomasville	273	49	58	29.79	30.08	−.07	55.2	+2.7	78	12	65	32	4	46	37				4.74		13		e.								.0	.0
Apalachicola	35	11	51	30.02	30.06		58.5	+2.8	77	1	65	39	4	52	24	55	53	88	7.58	+2.5	13	9.3	ne.	31	e.	19	4	8	19	7.5	.0	.0
Pensacola	56	54	79	30.00	30.06	−.09	57.4	+3.4	76	1	64	38	4	50	24	53	50	80	10.24	+5.6	15	8.9	e.	34	se.	26	8	5	18	6.6	.0	.0
Anniston	741	9		29.32	30.12	−.04	49.6	+5.4	71	11	58	22	4	41	37				4.27		13		se.				15	4	12		.0	.0
Birmingham [2]	700	11	48	29.35	30.11	−.05	50.6	+4.2	71	11	59	26	4	43	30	44	41	81	4.32	−.8	13	7.7	n.	24	se.	15	13	2	16	5.9	.0	.0
Mobile [2]	57	86	161	30.00	30.06	−.09	57.0	+4.8	75	11	65	37	3	49	32	51	49	86	7.74	+2.7	13	10.5	n.	42	e.	26	7	7	17	6.7	.0	.0
Montgomery [2]	218	92	105	29.86	30.09	−.07	53.0	+3.6	74	11	61	31	4	45	31	46	43	80	6.79	+2.0	13	7.1	e.	31	e.	26	10	3	18	6.7	.0	.0
Meridian [2]	375	67	92	29.67	30.08	−.08	52.4	+4.7	75	12	62	30	4	43	35	47	45	85	7.95	+2.7	13	6.2	ne.	32	e.	26	11	5	15	5.9	.0	.0
Vicksburg	247	82	102	29.80	30.07	−.08	53.4	+3.4	75	12	62	34	2	45	29	48	43	74	6.79	+1.5	12	9.0	n.	27	n.		8	5	18	6.5	.0	.0
New Orleans [2]	53	76	84	29.99	30.05	−.08	59.4	+3.8	81	12	66	45	17	53	23	54	52	83	8.09	+3.3	12	7.6	ne.	21	nw.	26	8	7	16	6.4	.0	.0
Port Eads, La.	9	4	35																													
West Gulf States							53.6	+3.2										81	5.27	+2.3										6.3		
Shreveport [2]	249	92	227	29.80	30.06	−.07	52.8	+3.7	71	9	62	29	16	44	29	48	44	80	7.91	+3.6	11	10.5	ne.	42	ne.	26	8	9	14	6.2	.0	.0
Bentonville	1,303	12	51	28.75	30.14	+.01	42.6	+5.1	70	19	52	21	16	34	35				3.64	+1.3	10	6.9	sw.	20	sw.	9	11	4	16	6.0	T	.0
Fort Smith	463	57	82	29.61	30.10	−.03	46.0	+3.9	75	9	55	26	16	37	40	41	36	73	3.44	+.7	11	7.3	e.	23	w.	15	13	4	14	5.8	.0	.0
Little Rock [2]	357	94	102	29.71	30.10	−.04	48.2	+4.0	69	9	56	28	16	40	36	42	40	85	3.02	−1.1	8	8.3	e.	28	ne.	15	10	6	15	6.1	.0	.0
Austin [2]	605	68	90	29.41	30.05		53.6	+2.6	72	28	62	31	16	45	36	49	46	82	5.32	+2.7	10	7.6	n.	29	nw.	26	9	7	15	6.1	.0	.0
Brownsville [2]	57	88	96	29.94	30.00		63.9	+2.7	82	1	71	43	16	57	30	59	57	85	6.95	+5.4	10	11.7	nw.	43	nw.	26	6	9	16	6.7	.0	.0
Corpus Christi [2]	20	11	78	30.00	30.04	−.10	60.9	+2.9	78	11	67	40	16	55	28	56	55	88	2.12	+.7	10	10.6	n.	32	nw.	27	5	8	18	6.8	.0	.0
Dallas [1]	512	220	227	29.52	30.08		48.8		72	9	58	26	16	39	33	44	41	81	4.85	+2.5	11	9.9	n.	42	n.	26	12	5	14	5.9	.0	.0
Fort Worth	679	35	56	29.35	30.08	−.04	48.9	+1.4	73	9	58	28	16	39	34	43	40	80	4.72	+2.8	10	10.6	n.	44	n.	26	11	6	14	5.9	.0	.0
Galveston [2]	54	106	114	29.97	30.03	−.09	59.0	+2.6	71	6	64	40	16	54	18	55	53	86	8.08	+4.3	14	9.7	n.	33	nw.	27	9	5	17	6.2	.0	.0
Houston [2]	138	157	190	29.89	30.05		58.3	+3.9	75	10	66	32	16	51	24	53	51	85	5.30	+1.1	13	10.2	se.	28	n.	27	7	6	18	6.8	.0	.0
Palestine	510	64	72		30.07	−.05	53.0	+3.1	71	10	61	28	16	45				73	5.87	+2.2	11	7.1	n.	23	n.	26	10	6	15		.0	.0
Port Arthur	34	59	134	30.00	30.04		58.2		74	1	65	37	16	52	23				9.75	+4.5	14	12.8	ne.	31	se.	25	7	6	18	6.7	.0	.0
San Antonio [2]	603	111	301	29.31	30.04	−.07	56.8	+3.1	78	28	65	34	16	48	37	52	48	79	2.85	+1.2	10	11.8	ne.	40	n.	26	11	3	17	6.2	.0	.0

See footnotes at end of table.

CLIMATOLOGICAL DATA FOR WEATHER BUREAU STATIONS—Continued

District and station	Elevation of instruments: Barometer above sea level	Elevation: Thermometer above ground	Elevation: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature: Mean max.+mean min.÷2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 inch, or more	Wind: Total movement	Wind: Average hourly velocity	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Ohio Valley and Tennessee							**41.5**	**+5.2**										**82**	**2.81**	**−0.7**										**7.4**		
Chattanooga [1]	762	21	54	29.29	30.13	−0.03	44.4	+1.1	67	11	55	17	4	34	40	40	38	86	4.47	-----	12	5.4	n.	24	sw.	29	7	7	17	6.8	T	0.0
Knoxville [2]	995	66	84	29.04	30.12	−.04	46.2	+5.9	68	27	55	20	4	37	31	41	37	80	2.90	−1.6	11	5.5	ne.	20	sw.	16	9	8	14	6.1	-----	-----
Memphis [2]	399	78	86	29.66	30.10	−.05	48.4	+4.8	69	11	56	27	2	41	32	42	38	80	3.17	−1.3	12	7.9	e.	26	w.	15	9	11	11	5.8	.0	.0
Nashville [2]	546	167	187	29.52	30.11	−.04	46.0	+5.0	68	10	54	22	4	38	30	41	38	82	2.44	−1.8	14	8.5	s.	31	s.	7	6	10	15	6.6	.0	.0
Lexington	989	6	----	29.04	30.14	.00	41.4	+5.6	64	24	50	13	3	33	31	----	----	----	3.24	-----	15	-----	-----	-----	-----	-----	8	1	22	7.5	.0	.0
Louisville [2]	525	106	120	29.54	30.12	−.02	42.4	+4.8	62	24	50	12	3	35	30	38	34	82	3.10	−.6	10	9.0	sw.	32	sw.	16	4	8	19	7.6	.0	.0
Evansville [1]	431	76	116	29.64	30.11	−.02	40.8	+3.7	63	9	49	12	3	33	34	37	34	81	2.32	−1.2	12	8.9	nw.	28	w.	16	3	11	17	7.5	.0	.0
Indianapolis [2]	823	98	129	29.20	30.11	−.01	37.6	+5.4	61	9	45	5	3	31	29	33	31	86	2.58	−.4	9	8.9	nw.	25	w.	16	3	6	22	8.1	T	.0
Terre Haute	575	68	149	29.49	30.12	-----	37.8	-----	61	24	45	4	3	31	33	33	31	85	2.89	.0	10	10.3	nw.	31	sw.	16	3	9	19	7.9	T	.0
Cincinnati [2]	627	11	51	29.43	30.12	−.01	39.8	+6.4	60	12	47	11	3	32	28	36	33	82	2.38	−.6	11	8.2	sw.	27	sw.	16	5	5	21	7.7	T	.0
Columbus [2]	822	90	110	29.21	30.10	−.02	38.8	+6.4	62	25	45	12	3	32	26	34	31	82	2.72	.0	13	10.2	s.	33	sw.	16	3	8	20	7.9	.1	.0
Dayton	900	186	213	29.13	30.12	-----	37.8	+5.2	60	24	45	9	3	31	29	34	31	85	3.13	+.4	12	10.8	sw.	41	sw.	16	3	7	21	7.7	T	.0
Elkins [2]	1,947	61	78	28.03	30.13	+.01	40.6	+7.9	64	16	51	2	4	30	43	35	31	78	1.83	−1.6	17	6.6	w.	26	w.	17	5	6	20	7.5	.7	.0
Parkersburg	637	77	84	29.42	30.12	−.02	41.9	+6.7	65	16	50	12	4	33	36	37	33	77	2.42	−.6	12	5.9	sw.	21	sw.	16	4	10	17	7.4	T	.0
Pittsburgh [1]	842	39	54	29.18	30.10	−.01	38.1	+3.9	64	16	46	6	4	31	30	34	31	79	2.62	−.2	14	11.0	nw.	35	w.	1	3	6	22	8.3	2.4	T
Lower Lake Region							**32.2**	**+2.8**										**83**	**3.21**	**+0.5**										**8.3**		
Buffalo [2]	768	243	280	29.22	30.08	+.02	32.8	+3.0	58	25	39	5	3	27	24	30	27	83	3.37	-----	17	15.5	w.	49	w.	7	3	8	20	7.9	12.1	.1
Canton	448	10	61	29.58	30.08	-----	21.8	−.9	47	25	32	−21	3	12	42	22	20	87	3.43	+.7	20	8.5	w.	34	sw.	7	5	7	19	7.6	15.7	1.5
Ithaca	836	77	100	29.14	30.08	-----	32.4	+3.4	56	25	40	0	3	25	32	----	----	----	2.44	+.1	15	9.8	se.	27	se.	16	3	5	23	8.4	4.4	.0
Oswego	335	71	85	29.70	30.08	+.02	30.6	+1.6	57	25	38	0	3	24	27	29	25	76	2.84	−.7	16	10.6	se.	34	n.	17	2	7	22	8.4	8.2	T
Rochester [2]	523	86	102	29.50	30.09	+.03	30.8	+1.5	60	25	38	−3	3	23	30	29	26	86	2.84	+.1	17	10.1	sw.	36	sw.	7	2	9	20	8.0	7.0	.0
Syracuse [2]	596	65	79	29.42	30.09	+.02	30.3	+1.3	61	25	39	−3	4	22	37	28	25	84	3.78	+.7	19	9.1	sw.	34	sw.	10	3	3	25	8.5	8.6	T
Erie [2]	714	57	81	29.30	30.10	+.03	35.6	+3.7	61	25	42	12	4	30	27	32	29	85	3.50	+.7	13	8.8	s.	24	s.	7	3	4	24	8.5	10.3	T
Cleveland [2]	762	267	318	29.25	30.10	+.01	36.7	+5.5	63	16	43	12	4	30	35	32	29	81	4.07	+1.6	15	15.6	w.	44	w.	7	3	3	25	8.7	6.0	T
Sandusky	629	5	67	-----	-----	-----	34.8	+3.6	60	25	41	10	4	29	33	----	----	----	3.50	+1.2	14	9.5	sw.	26	nw.	1	3	5	23	8.3	5.7	.7
Toledo [2]	628	79	87	29.40	30.10	+.02	34.0	+3.6	57	24	40	10	3	28	27	30	28	84	3.55	+1.2	13	10.0	w.	29	w.	7	6	3	22	7.8	6.7	.4
Fort Wayne [2]	857	69	84	29.16	30.11	-----	34.2	+4.9	57	24	40	7	3	28	32	31	28	84	2.18	−.4	10	9.3	w.	27	w.	16	2	5	24	8.5	2.1	.0
Detroit [1]	730	5	78	29.29	30.10	+.03	32.0	+2.3	53	26	38	6	3	26	25	30	26	81	2.98	+.6	10	10.5	nw.	30	sw.	16	1	5	25	8.7	4.3	.1
Upper Lake Region							**26.9**	**+3.0**										**85**	**1.58**	**−0.4**										**8.2**		
Alpena	609	13	89	29.38	30.07	+.05	27.6	+2.8	43	10	33	−2	3	22	22	26	24	88	1.76	−.3	15	10.0	nw.	31	nw.	10	4	5	22	7.9	10.8	6.6
Escanaba	612	51	72	29.39	30.08	+.05	24.2	+1.8	40	26	30	−7	3	18	22	23	21	85	1.39	−.4	9	10.2	nw.	32	n.	12	4	4	23	8.0	10.8	1.0
Grand Rapids [2]	707	70	244	29.30	30.09	+.04	31.9	+3.4	51	24	36	8	3	27	22	28	26	86	2.05	−.5	16	11.0	s.	36	sw.	16	1	3	27	8.9	7.0	T
Lansing	878	5	90	29.12	30.10	-----	30.2	+3.0	52	25	35	3	3	25	20	28	26	89	2.66	+.6	14	8.7	nw.	25	s.	6	2	3	26	8.7	9.6	4.0
Marquette	734	44	73	29.22	30.05	+.03	25.2	+2.6	44	21	30	−2	3	20	23	24	21	85	1.64	−1.0	9	9.3	nw.	28	s.	9	4	5	22	7.9	15.0	4.1
Sault Sainte Marie [2]	614	11	52	29.35	30.05	+.05	23.6	+3.1	41	25	30	−11	3	17	26	22	19	86	2.12	−.2	21	7.3	se	37	nw.	7	2	3	26	8.8	25.2	4.9
Chicago	673	7	131	29.36	30.11	+.03	33.5	+4.7	53	24	39	−5	3	28	25	31	28	80	1.38	−.7	13	10.9	s.	26	sw.	16	5	3	23	8.0	4.1	.0
Green Bay	617	109	141	29.39	30.09	+.05	24.3	+2.0	43	25	30	−13	3	19	28	24	21	83	1.38	−.3	9	10.1	s.	25	w.	7	5	1	25	8.1	7.7	T
Milwaukee [2]	681	126	221	29.34	30.10	+.04	29.5	+3.4	47	26	35	−9	3	24	21	27	24	85	.95	−.8	8	12.6	n.	33	n.	16	1	9	21	8.4	1.3	.0
Duluth	1,133	5	47	28.79	30.07	+.02	18.9	+3.0	45	24	26	−19	13	12	37	17	15	86	.51	−.6	10	11.7	nw.	47	nw.	9	5	6	20	7.5	5.7	.6
North Dakota							**20.3**	**+6.7**										**88**	**0.41**	**−0.2**										**6.3**		
Moorhead, Minn. [2]	940	50	58	-----	-----	-----	-----	-----	----	----	----	----	----	----	----	----	----	----	-----	-----	----	-----	-----	-----	-----	-----	----	----	----	----	----	----
Bismarck [1]	1,677	4	41	28.20	30.07	−.01	22.0	+7.3	47	20	33	−21	13	11	40	20	17	86	.10	−.5	4	8.4	nw.	42	nw.	9	10	4	17	6.3	1.8	.4
Devils Lake	1,478	11	44	28.40	30.05	−.01	16.1	+6.6	41	6	26	−25	12	7	40	16	15	94	.56	.0	8	8.1	sw.	33	nw.	6	7	3	21	7.4	4.2	4.2
Lemmon, S. D	2,602	4	38	29.28	30.05	-----	26.2	-----	55	23	37	−12	13	15	38	23	20	----	.16	-----	2	-----	nw.	-----	-----	-----	11	8	12	----	1.0	1.0
Grand Forks	832	12	67	29.13	30.08	-----	15.9	+5.3	37	21	24	−21	12	7	36	16	14	----	.88	-----	6	-----	se.	-----	-----	-----	6	3	22	----	7.3	7.3
Williston	1,878	42	50	27.98	30.03	−.03	21.4	+7.6	44	5	31	−21	12	12	40	20	17	83	.35	−.2	6	5.4	sw.	28	w.	9	11	7	13	5.3	1.9	2.3
Upper Mississippi Valley							**30.9**	**+3.9**										**84**	**1.82**	**+0.2**										**7.4**		
Minneapolis-St. Paul, Minn.	919	32	61	29.06	30.10	+.02	22.0	+2.4	44	24	29	−19	3	15	41	21	18	85	1.02	.0	9	9.8	s.	33	nw.	6	3	8	20	7.5	10.6	2.5
Springfield, Minn	1,025	4	42	28.95	30.01	-----	23.0	-----	43	24	30	−16	3	16	46	21	19	----	1.49	-----	10	-----	s.	-----	-----	-----	5	8	18	----	12.0	1.7
La Crosse [2]	714	11	48	29.30	30.10	+.02	25.4	+3.1	46	24	32	−19	3	19	38	23	20	85	1.55	+.2	6	5.8	s.	18	w.	9	4	4	23	7.9	11.5	.4
Madison [2]	974	70	78	29.02	30.11	+.03	26.2	+3.4	46	9	31	−12	3	21	24	24	22	86	1.38	−.2	9	9.0	n.	22	nw.	16	1	9	21	8.1	3.5	T
Charles City	1,015	10	51	28.99	30.12	+.02	24.6	+4.2	48	9	32	−15	3	18	35	24	22	88	1.58	+.3	9	6.6	n.	20	nw.	7	6	5	20	7.7	16.3	1.3
Davenport [2]	606	66	161	29.43	30.12	+.02	32.4	+5.3	60	9	39	−4	3	26	29	30	27	86	1.78	+.3	7	9.2	nw.	30	nw.	7	4	7	20	7.6	2.7	.0
Des Moines [2]	860	5	99	29.14	30.09	+.02	30.2	+4.2	55	9	37	0	3	23	29	27	24	83	1.46	+.2	7	9.5	n.	29	nw.	16	7	5	19	7.3	15.4	T.
Dubuque	699	60	79	29.33	30.12	+.02	29.2	+4.5	54	9	35	−9	3	24	28	27	24	83	2.01	+.6	8	6.5	nw.	21	nw.	7	3	7	21	8.1	6.5	1.2
Keokuk	614	64	78	29.43	30.11	−.01	35.4	+5.8	68	9	42	0	3	29	29	29	26	80	1.84	+.4	7	7.8	sw.	25	sw.	16	9	3	19	6.8	.1	.0
Cairo	358	87	93	29.72	30.11	−.04	43.4	+5.6	65	9	51	20	3	36	33	----	----	----	2.92	−.5	11	8.5	n.	29	sw.	16	4	8	19	7.2	.2	.0
Peoria [2]	609	11	45	29.43	30.11	.00	34.0	+5.9	62	9	40	−1	3	28	25	31	29	87	1.67	−.1	8	7.0	s.	20	sw.	16	8	3	20	6.9	.3	.0
Springfield, Ill. [2]	636	5	191	29.41	30.11	−.01	36.4	+4.7	63	9	42	3	3	30	28	32	31	89	1.73	−.4	9	10.8	n.	28	s.	9	6	6	19	7.3	1.5	.0
St. Louis [5]	568	179	303	29.49	30.12	−.01	39.9	+5.0	69	9	46	11	3	33	31	36	32	76	3.21	+1.0	12	11.4	nw.	35	sw.	9	8	7	16	6.7	T	.0
Missouri Valley							**33.1**	**+4.7**										**83**	**1.52**	**+0.4**										**6.8**		
Columbia, Mo. [2]	784	6	66	29.24	30.11	−0.01	38.0	+4.8	73	9	45	11	3	31	34	33	30	80	2.91	+1.0	8	8.0	w.	24	sw.	16	6	10	15	6.6	1.7	.0
Kansas City [1]	963	38	76	29.04	30.11	−.01	37.2	+4.7	67	9	45	11	17	30	32	33	29	77	1.68	+.4	9	10.1	sw.	37	sw.	6	7	4	20	6.8	1.2	0
St. Joseph [2]	967	11	49	29.05	30.12	-----	34.9	+5.3	62	9	42	8	17	28	24	30	28	88	1.55	+.3	6	8.4	w.	27	nw.	16	8	6	17	6.7	3.9	.0
Springfield, Mo. [1]	1,324	5	78	28.66	30.10	−.03	39.4	+3.2	71	9	48	17	17	31	33	35	32	84	2.63	+.3	12	11.2	se.	31	s.	9	8	5	18	6.9	.2	.0
Topeka	987	65	87	29.02	30.11	-----	36.2	+4.2	66	9	44	8	17	29	31	32	29	79	1.31	+.5	11	8.7	w.	22	nw.	4	9	4	18	6.7	5.4	.0
Lincoln [2]	1,189	11	81	28.79	30.11	−.01	31.1	+3.5	58	9	38	0	13	24	20	26	24	86	1.30	+.5	8	9.0	s.	28	n.	2	9	5	17	7.1	15.3	.0
Omaha [1]	1,105	31	44	28.89	30.11	.00	30.5	+4.1	56	9	38	−2	13	23	29	26	25	83	1.39	+.5	7	9.6	se.	31	nw.	4	5	5	21	7.4	11.0	.0
Valentine	2,598	46	54	27.27	30.07	−.03	30.6	+6.0	60	5	41	−5	14	20	34	26	22	78	1.00	+.4	8	8.2	w.	33	nw.	6	13	7	11	5.5	6.6	1.0
Sioux City [2]	1,138	64	106	-----	30.10	−.02	28.8	+5.7	50	6	36	−2	13	22	31	26	----	87	1.07	+.2	7	9.0	s.	33	nw.	4	1	11	19	----	11.0	1.0
Huron [1]	1,301	26	41	28.64	30.09	−.01	24.4	+5.7	49	8	33	−10	12	16	39	23	20	84	.33	−.2	9	11.9	s.	38	nw.	6	6	5	20	7.3	5.0	−.8
Northern Slope							**28.9**	**+5.2**										**74**	**0.34**	**−0.4**										**6.2**		
Billings [1]	3,570	18	39	26.27	30.01	-----	32.6	-----	63	5	42	−4	13	23	27	27	20	61	.06	-----	3	13.0	sw.	52	nw.	5	10	6	15	6.0	1.1	.1
Havre	2,507	11	67	27.30	30.02	−.03	27.0	+6.4	62	8	37	−17	12	17	42	23	19	76	.04	−.6	2	8.2	w.	34	sw.	5	11	7	13	5.3	1.4	.0
Helena	4,124	85	111	25.76	30.10	−.03	28.7	+4.5	59	8	38	−9	14	19	30	24	19	72	.04	−.7	2	7.0	w.	42	sw.	6	4	11	16	6.7	.5	.0
Missoula [1]	3,263	80	91	26.64	30.12	-----	30.4	+5.9	54	8	36	3	14	24	23	26	23	86	.23	−.9	8	5.7	se.	22	sw.	8	4	8	19	7.4	1.4	T
Kalispell	2,973	48	56	26.94	30.05	−.02	29.1	+4.2	54	8	34	−1	17	24	25	27	24	88	.81	−.6	14	4.1	w.	24	sw.	5	1	3	27	8.5	4.5	.8
Miles City [1]	2,371	48	55	27.48	30.05	−.05	28.6	+7.6	52	24	39	−6	12	18	37	24	20	77	.39	−.2	6	5.2	s.	25	nw.	9	12	6	13	5.3	5.3	1.5
Rapid City [2]	3,259	50	58	26.59	30.06	−.05	32.4	+5.5	66	5	43	−4	14	22	51	26	21	72	.34	−.1	5	7.1	w.	29	nw.	6	10	10	11	5.3	4.3	.0
Cheyenne [1]	6,094	5	39	23.94	30.06	−.03	31.4	+2.9	64	8	42	−13	14	20	32	24	17	59	.28	−.3	3	12.6	nw.	45	w.	5	8	8	15	6.2	4.5	T
Lander	5,352	60	68	24.64	30.14	−.01	23.8	+3.4	58	5	36	−13	14	12	40	20	16	76	.43	−.2	4	4.0	e.	26	w.	6	9	11	11	5.7	4.8	.4
Sheridan [6]	3,790	10	47	26.06	30.07	-----	27.2	-----	63	3	40	−13	14	15	42	22	19	78	.26	−.4	5	4.9	nw.	38	nw.	27	9	8	14	6.0	6.7	.8
Yellowstone Park	6,241	12	46	23.86	30.19	+.03	24.8	+7.8	47	8	32	−11	14	17	30	22	18	75	.49	−.3	10	8.6	s.	32	sw.	5	7	10	14	6.4	6.6	2.3
North Platte [1]	2,821	11	51	27.07	30.09	−.01	30.8	+4.1	67	5	41	−5	14	21	43	25	22	80	.68	+.2	7	6.9	w.	24	nw.	6	12	6	13	5.3	5.3	T

See footnotes at end of table.

CLIMATOLOGICAL DATA FOR WEATHER BUREAU STATIONS—Continued

District and station	Elevation of instruments			Pressure			Temperature of the air												Precipitation			Wind										
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew-point	Mean relative humidity	Total	Departure from normal	Days with 0.01 inch, or more	Total movement	Average hourly velocity	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Middle Slope							**36.1**	**+3.1**										**76**	**0.90**	**+0.2**										**5.2**		
Denver [2]	5,292	106	113	24.70	30.06	−0.02	35.6	+3.3	73	8	46	−5	14	25	37	26	18	59	.31	−0.4	3	6.7	s.	26	nw.	6	12	14	5	4.2	5.4	0.0
Pueblo	4,690	79	86	25.27	30.09	+.01	32.7	+1.2	75	8	47	−18	14	18	55	25	20	71	.42	−.1	3	7.2	w.	33	w.	6	9	13	9	5.4	8.1	.0
Concordia	1,392	50	58	28.59	30.11	.00	33.0	+2.3	60	9	40	6	13	26	27	30	28	85	1.25	+.6	8	7.8	ne.	24	nw.	28	10	7	14	5.9	12.4	.0
Dodge City	2,509	10	86	27.41	30.08	−.02	37.8	+5.2	71	8	48	8	13	28	40	32	28	77	.79	+.2	6	10.0	nw.	28	sw.	5	12	9	10	5.2	5.5	.0
Wichita [2]	1,358	85	93	28.62	30.10	−.01	37.5	+2.9	66	8	46	13	15	29	35	33	31	86	1.56	+.6	6	14.2	s.	30	n.	27	14	5	12	5.2	.7	.0
Oklahoma City [2]	1,214	10	47	28.78	30.09	−.02	43.0	+3.7	70	9	51	20	14	35	29	38	35	81	1.89	+.4	6	9.5	s.	24	n.	27	13	6	12	5.4	T	.0
Chadron, Nebr.	3,439	5	44	26.44	30.06	.....	33.0	.....	64	5	43	−12	14	23	39	27	21	...	.10	.....	4	.....	sw.	.....	.....	.....	12	11	8	.....	2.0	.0
Southern Slope							**48.1**	**+4.0**										**70**	**0.60**	**−0.3**										**5.1**		
Abilene [2]	1,738	10	56	28.22	30.06	−.05	48.3	+2.3	74	4	58	24	16	38	31	42	38	79	1.68	+.3	8	8.9	s.	31	n.	26	10	5	16	5.9	T	.0
Amarillo [2]	3,676	10	49	26.26	30.06	−.03	42.5	+5.5	77	9	53	14	14	32	40	33	29	76	.27	−.5	5	8.8	sw.	26	w.	25	14	9	8	4.2	.8	.0
Del Rio	960	63	71	29.03	30.03	−.07	55.4	+3.2	83	28	65	32	16	46	46	49	43	68	.38	−.3	5	8.6	nw.	40	nw.	26	7	8	16	6.4	.0	.0
Roswell	3,566	75	85	26.38	30.03	−.04	46.2	+5.0	75	4	60	21	16	32	46	38	29	58	.08	−.6	3	7.2	s.	40	nw.	25	17	4	10	3.9	.0	.0
Southern Plateau							**45.**	**0+4.3**										**68**	**1.87**	**+1.0**										**5.0**		
El Paso [2]	3,778	82	101	26.20	30.02	−.01	50.4	+5.5	70	4	62	28	16	39	32	41	32	58	.31	−.2	6	6.7	w.	29	w.	25	14	13	4	3.7	.0	.0
Albuquerque [1]	4,972	5	34	25.08	30.06	.....	39.2	+4.7	60	6	50	17	16	28	32	33	28	69	.87	+.4	10	7.7	n.	42	nw.	25	15	5	11	4.8	.5	.0
Santa Fe	7,013	38	53	23.22	30.12	+.06	35.2	+4.5	55	3	44	9	16	26	27	28	24	78	2.07	+1.3	8	6.6	n.	24	e.	12	13	4	14	5.2	12.0	.5
Flagstaff	6,907	10	59	23.33	30.00	−.06	33.6	+5.2	60	8	45	−1	15	22	39	30	27	79	3.14	.....	10	7.1	nw.	27	s.	12	9	9	13	5.5	.....	4.0
Phoenix [2]	1,107	39	87	28.82	29.98	−.06	56.8	+4.8	83	8	68	32	15	46	38	49	44	71	3.75	+2.8	10	5.0	e.	22	se.	29	7	6	18	6.5	.0	.0
Yuma	142	9	54	29.84	29.99	−.06	59.0	+3.8	80	3	69	39	15	49	33	50	40	55	.79	+.3	6	5.8	n.	28	w.	24	15	10	6	4.2	.0	.0
Independence	3,957	5	26	25.98	30.07	−.05	40.8	+1.5	71	2	52	10	15	30	38	33	22	...	2.15	+1.4	8	4.8	nw.	.....	.....	.....	11	6	14	.....	6.0	.0
Middle Plateau							**33.9**	**+3.5**										**75**	**1.13**	**+0.2**										**6.0**		
Ely, Nev.	6,262	5	41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Reno [2]	4,527	61	76	25.43	30.03	−0.12	37.8	+4.5	69	3	48	6	14	28	40	31	26	69	1.71	+.7	10	5.2	w.	28	se.	24	16	3	12	5.0	2.3	.0
Tonopah	6,090	12	20	24.02	30.05	.....	35.3	.....	60	4	42	6	14	29	23	30	24	...	.46	.....	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.6	.5
Winnemucca	4,339	5	56	25.59	30.04	−.14	34.2	+4.2	64	3	46	−3	14	23	39	30	25	71	1.41	+.3	10	6.9	ne.	24	s.	23	9	6	16	5.9	1.6	.0
Modena	5,473	10	46	.....	30.10	−.02	30.6	+2.5	64	8	42	−15	15	20	43	.....	.....	...	.68	−.2	10	7.3	w.	34	sw.	23	8	4	19	6.8	5.7	.0
Salt Lake City [2]	4,357	86	210	25.65	30.14	−.01	34.7	+2.8	56	5	42	9	15	27	24	29	27	84	1.46	.0	11	5.4	nw.	29	nw.	27	7	11	13	6.1	8.6	1.5
Grand Junction	4,602	60	68	25.46	30.12	+.02	31.0	+3.5	54	1	39	−3	15	23	30	28	24	76	1.07	+.4	7	4.3	se.	22	s.	12	8	7	16	6.4	8.4	.0
Northern Plateau							**34.1**	**+3.6**										**81**	**1.47**	**−0.2**										**6.8**		
Baker [1]	3,471	36	54	26.44	30.09	−.07	33.2	+5.9	53	5	41	5	14	26	25	28	26	84	.54	−1.2	6	5.9	s.	24	se.	21	8	6	17	6.1	.2	T
Boise [1]	2,739	5	49	27.20	30.10	−.10	35.3	.....	55	20	43	9	13	27	30	32	28	75	.54	.....	9	9.5	se.	40	e.	23	11	5	15	5.8	T	.0
Pocatello [1]	4,477	5	31	25.50	30.13	−.06	31.0	.....	57	5	40	−2	14	22	35	28	24	77	1.64	.....	9	8.0	sw.	34	w.	27	7	9	15	6.3	4.1	1.7
Spokane [2]	1,929	101	110	27.97	30.05	−.03	33.9	+3.4	51	22	39	9	14	29	17	32	30	86	2.59	+.4	14	5.5	n.	21	sw.	5	7	1	23	7.3	1.0	T
Walla Walla	991	57	65	28.96	30.05	−.07	37.0	+1.5	63	21	44	14	14	30	30	.....	.....	...	1.66	−.4	14	4.9	s.	27	se.	21	2	3	26	8.9	T	.0
Yakima	1,076	58	67	28.87	30.05	.....	34.2	+3.5	53	8	41	11	14	28	26	32	29	82	1.87	+.5	11	4.0	nw.	25	nw.	5	10	3	18	6.4	1.3	.0
North Pacific Coast Region							**44.7**	**+3.2**										**80**	**6.44**	**−0.8**										**7.6**		
North Head	211	5	56	29.66	29.89	−.14	46.5	+2.4	58	2	50	34	12	42	14	44	39	77	8.18	−1.3	22	17.0	e.	84	s.	21	6	4	21	7.4	T	.0
Seattle [2]	125	90	321	29.80	29.94	−.05	46.4	+4.7	63	21	51	30	14	42	20	42	38	80	4.04	−1.6	19	9.5	se.	47	s.	22	8	4	19	7.2	.0	.0
Tacoma	194	172	201	29.72	29.94	−.05	44.6	+4.0	64	21	50	23	15	40	22	.....	.....	...	3.80	−2.9	19	7.2	s.	52	s.	21	6	4	21	7.4	.0	.0
Tatoosh Island	86	9	61	29.77	29.86	−.10	46.6	+2.7	57	21	50	35	12	43	12	44	40	79	14.10	+.7	23	19.7	e.	78	s.	22	8	2	21	7.2	T	.0
Medford [1]	1,329	29	58	28.54	29.98	.....	41.4	+4.0	63	21	48	19	14	35	25	39	35	81	3.41	+.3	13	.....	se.	.....	.....	.....	3	6	22	8.0	T	.0
Portland, Oreg. [2]	154	68	106	29.78	29.96	−.11	44.0	+2.8	63	21	49	29	15	39	19	40	36	81	5.03	−1.7	16	5.9	se.	27	s.	21	5	4	22	7.5	.0	.0
Roseburg	510	45	76	29.39	29.94	−.17	43.6	+1.8	70	21	51	17	14	37	29	42	39	84	6.54	+1.2	14	3.8	s.	21	s.	21	1	8	22	8.3	.0	.0
Middle Pacific Coast Region							**52.0**	**+4.0**										**73**	**10.62**	**+5.9**										**6.1**		
Eureka	60	72	88	29.85	29.92	−.20	50.6	+2.4	67	21	57	30	14	44	23	48	45	81	8.87	+2.6	15	7.2	se.	34	s.	21	5	6	20	7.0	.0	.0
Redding [1]	722	20	34	29.17	29.95	.....	51.2	+5.1	72	8	58	31	14	44	28	45	36	63	17.97	+12.4	14	9.7	nw.	37	s.	17	11	3	17	6.2	.0	.0
Sacramento [2]	66	92	115	29.89	29.96	−.18	50.6	+4.4	70	5	59	23	14	42	32	46	41	74	9.40	+6.4	14	8.3	n.	34	se.	23	14	3	14	5.5	.0	.0
San Francisco	155	112	132	29.76	29.93	−.19	55.4	+4.1	71	9	61	42	14	50	20	51	46	74	6.25	+2.3	14	7.2	e.	33	se.	24	11	8	12	5.6	.0	.0
South Pacific Coast Region							**57.7**	**+4.7**										**66**	**5.61**	**+3.6**										**6.0**		
Fresno [1]	327	5	35	29.63	29.99	−.14	51.0	+4.8	68	2	61	23	13	41	33	47	42	72	5.24	+3.8	10	4.3	se.	20	se.	24	11	4	16	5.8	.0	.0
Los Angeles	338	223	250	29.61	29.97	−.10	61.2	+4.6	88	7	70	45	13	53	27	51	42	56	5.50	+2.9	11	8.3	ne.	32	e.	16	6	11	14	6.0	.0	.0
San Diego	87	62	70	29.87	29.97	−.10	60.8	+4.8	84	3	70	44	26	52	32	53	48	70	6.09	+4.2	9	6.0	n.	33	s.	24	9	8	14	6.1	.0	.0
West Indies							**77.1**	**+0.8**											**3.54**	**−2.0**										**4.8**		
San Juan, P. R.	82	10	54	29.91	30.00	.....	77.1	+.8	86	27	82	68	22	72	15	.....	.....	...	3.54	−2.0	17	11.6	e.	33	e.	5	7	20	4	4.8	.0	.0
Panama Canal							**81.9**	**+2.0**										**82**	**2.22**	**−5.8**										**6.0**		
Balboa Heights	118	6	92	.....	[3] 29.80	−.02	81.4	+1.4	92	1	89	72	26	74	20	.....	.....	85	.20	−4.4	8	5.9	nw.	20	n.	5	3	27	1	5.2	.0	.0
Cristobal	36	6	97	.....	[3] 29.82	−.02	82.4	+2.5	89	26	86	75	8	78	14	76	75	78	4.25	−7.3	16	11.3	n.	27	n.	31	1	17	13	6.9	.0	.0
Alaska							**16.4**	**+3.5**										**78**	**2.38**	**−0.7**										**8.4**		
Fairbanks	454	11	87	.....	29.71	.....	−4.0	+3.0	45	10	4	−38	15	−12	.....	.....	.....	...	.29	−.3	8	3.3	n.	19	w.	13	7	11	13	.....	5.7	7.8
Juneau	80	96	116	[4] 29.58	[4] 29.67	.....	34.8	+3.6	49	19	38	15	31	31	14	33	30	82	6.22	−1.4	21	7.1	se.	24	ne.	25	5	0	26	8.4	10.8	4.9
Nome	22	5	59	.....	29.62	.....	10.4	+3.9	34	19	17	−23	17	4	.....	.....	.....	75	.62	−.5	10	8.3	n.	36	n.	26	6	5	20	.....	5.0	9.0
Hawaiian Islands							**73.8**	**+1.4**										**73**	**.41**	**−3.6**										**5.5**		
Honolulu	38	86	100	29.91	29.95	.....	73.8	+1.4	83	15	78	62	26	69	16	67	63	73	.41	−3.6	13	8.5	ne.	28	e.	26	7	16	8	5.5	.0	.0

[1] Data are airport records.
[2] Barometric and hygrometric data from airport, other data from city records.
[3] Observations taken bihourly.
[4] Pressure not reduced to a mean of 24 hours.
[5] Barometric, hygrometric and temperature records from airport, other data from city office records.
[6] Wind, and clear, partly cloudy, and cloudy data, from city office records, other data from airport records.

NOTE.—Except as indicated by notes 1, 2, 5, and 6 data in table, are city office record.

SEVERE LOCAL STORMS

[Compiled by MARY O. SOUDER from reports submitted by Weather Bureau officials]

[The table herewith contains such data as has been received concerning severe local storms that occurred during the month. A revised list of tornadoes will appear in the United States Meteorological Yearbook]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks
Napoleonville, La	12	3 a. m.		0	$10,000	Tornado	Property damaged; 1 person injured.
Iowa	14-15					Snow, rain, and sleet.	The heaviest snow fell in the southwestern portion of the State, with 16 inches at Red Oak and 15 inches at Bedford, while the fall generally exceeded 10 inches over a broad belt extending from the southwestern to the northeastern corner of the State. Many roads were blocked especially in the rural areas and transportation was hampered. East of a line extending from Allamakee County southwestward to Ringgold County, the snow changed to sleet and freezing rain. In Keokuk County the coating of ice on wires and trees was reported to be an inch thick and coatings of more than half an inch were reported from Cedar, Johnson, Washington, and Henry Counties. Service was interrupted because many communication and power lines were broken.
Donaldsonville, La., 2 miles south.	15	1:15 p. m.		0	2,000	Tornado	Property damaged; 3 persons injured.
Iowa	15					Snow, rain and ice.	Snow ranging up to 6.5 inches fell in the northern two-thirds of Iowa, while in the southeastern and extreme eastern parts, heavy damage was caused by an all-day rain that froze as it fell. Damage to telephone and power lines.
Kansas, southeastern and south-central portions of the State.	15					Sleet and freezing rain.	Damage to telephone and power wires; travel on highways difficult and dangerous for several days.
Green Bay, Appleton, New London, and Shawano, Wis., and vicinities.	15-16				75,000	Snow and glaze	10 to 14 inches of snow recorded with much lighter falls in the far northwestern portion of the State. Highways were blocked by drifts greatly impeding traffic.
Nebraska	16					Snow	Drifting snow blocked many roads and highways.
Washington, western portion of the State.	21-22			2		Wind	Trees, poles, and wires blown down, temporary buildings destroyed. Boats were blown from their moorings, 1 being completely wrecked. Two persons killed by power line falling across their car. At North Head, Wash., wind attained a velocity of 84 miles an hour at 9:30 p. m., local time. All telegraph, telephone and power lines down due either directly to the wind or to trees falling over the wires.
Fort Myers, Fla	26	10:13 p. m.	50	0		Tornado	House demolished, others damaged; 2 persons injured.
Palatka, Fla	27	12:30 a. m.	200	0		do	Storm moved from south to west. Considerable damage to houses and trees; path a mile long.
Bunnell, Fla	27	12:50 a. m.	100	0		do	Storm moved from south-southwest to north-northeast. Four cabins in a tourist camp demolished. Several persons injured; path 10 miles long.
Boca Raton, Fla	27	1:30 a. m.	200	0		do	Storm moved from west-southwest to east-northeast. Damage mostly to trees with loss to some beach property.
De Land, Fla	27	A. m.				do	Damage to roofs and chimneys. Path narrow and 1½ miles long.
Fort Lauderdale, Fla	27	do		1		Wind	Property damaged; loss to crops; 1 person electrocuted.
Dothan, Ala.[1]	27			0		Tornado	Blowing in from the southeast, the twister ripped off part of the roof from a stable, jumped over Central of Georgia Railway tracks, skimmed past the city power plant, struck a cotton compress building and then plowed into a lumber yard. A negro was injured when his home was wrecked.

[1] From press reports.

SOLAR RADIATION AND SUNSPOT DATA FOR DECEMBER 1940

SOLAR RADIATION OBSERVATIONS

By HELEN CULLINANE

Measurements of solar radiant energy received at the surface of the earth are made at 9 stations maintained by the Weather Bureau and at 10 cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at two Weather Bureau stations (Madison, Wis.; Lincoln, Nebr.) and at the Blue Hill Observatory of Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau station at Madison and at Blue Hill Observatory.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data obtained, up to the end of 1936, will be found in the MONTHLY WEATHER REVIEW, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parentheses). At Lincoln the observations are made with the Marvin pyrheliometer; at Madison and Blue Hill they are obtained with a recording thermopile, checked by observations with a Smithsonian silver-disk pryheliometer at Blue Hill. The table also gives vapor pressures at 7:30 a. m. and at 1:30 p. m. (75th meridian time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, their departures form normal and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

Normal incidence radiation during December was above normal at Blue Hill, Mass., while the sky was unusually overcast at Madison, Wis.

No polarization measurements were made at Madison, Wis., due to overcast skies, or at Blue Hill, due to snow cover.

Total solar and sky radiation was below normal during December at all stations except New York and Twin Falls. Madison, Wis., experienced during the last week the lowest radiation it has had since the station opened in 1911. All stations except Blue Hill, Newport, and Fresno showed an excess in total solar and sky radiation during the entire year, while the greatest deficiency experienced was at Blue Hill.

LATE DATA

Total solar and sky radiation for Ithaca during August: July 30, 469, −1; Aug. 6, 486, +65; Aug. 13, 390, −54; Aug. 20, 484, +43.

Total solar and sky radiation for Chicago during November: Oct. 29, 190, +33; Nov. 5, 117, −18; Nov. 12, 190, +74; Nov. 19, 116, −2; Nov. 26, 106, +13. Total departure through Dec. 2, +6, 107.

TABLE 1.—*Solar radiation intensities during December 1940*

[Gram-calories per minute per square centimeter of normal surface]

Madison, Wis.

Date	Sun's zenith distance										
	7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	1:30 p. m.
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Dec. 3	0.41	1.04	1.19	1.28		1.50					0.58
Means		(1.04)	(1.19)	(1.28)		(1.50)					
Departures		+.06	+.09	+.06		−.05					

Blue Hill, Mass.

Date	75th mer. time (e)	5.0 A. M.	4.0 A. M.	3.0 A. M.	2.0 A. M.	*1.0	2.0 P. M.	3.0 P. M.	4.0 P. M.	5.0 P. M.	Local mean solar time (e)
Dec. 2	1.6	1.03	1.13	1.26	1.40						1.5
Dec. 3	1.5	1.05	1.13	1.25	1.38			1.28	1.14	1.04	1.0
Dec. 4	.8						1.43	1.19	1.03	0.92	0.9
Dec. 6	1.4	1.04	1.16	1.30	1.38						1.5
Dec. 9									.96	0.84	2.6
Dec. 14	1.3						1.46	1.29	1.15	1.03	1.1
Dec. 18	1.4	1.07	1.16	1.26	1.36			1.21	1.04	.90	1.5
Dec. 19	2.4	1.00	1.11	1.23							2.8
Dec. 21	1.3	1.03	1.12								2.0
Dec. 25	2.8		.96	1.09					.84	0.74	3.5
Means		1.04	1.11	1.23	1.38		1.44	1.24	1.03	.91	
Departures		+.15	+.06	+.05	+.03		+.15	+.10	−.02	−.05	

TABLE 1.—*Solar radiation intensities during December 1940*—Con.

LATE DATA

Blue Hill, Mass., November 1940

Date	Sun's zenith distance										
	7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	1:30 p. m.
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e
	mm.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	mm.
Nov. 1	5.0	0.91	1.02	1.15							5.4
Nov. 3	6.1	.70	.82	1.00							5.6
Nov. 4	4.6	.92	.98	1.11	1.25		1.22	0.95	0.78	0.69	4.6
Nov. 7	3.8	.83			1.21		1.21				4.0
Nov. 9	3.6	.96	1.04	1.18	1.31		1.30	1.15	1.01	.91	3.6
Nov. 19	2.8	1.04	1.12	1.22	1.32				1.03	.91	3.2
Nov. 21	4.2	1.03	1.12	1.24	1.36			1.15	.94		3.8
Nov. 22	8.2							.76			8.8
Nov. 25	3.2			1.27	1.42			1.27	1.14	1.05	8.2
Nov. 26	1.6		1.14								1.3
Nov. 28	2.8				1.36			1.19		.98	1.9
Nov. 30	3.0	.77	.87	1.11							2.1
Means		.91	1.01	1.16	1.32		1.28	1.08	.98	.91	
Departure		.00	.00	.03	.05		.03	−.02	.01	.07	

*Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface*

[Gram-calories per square centimeter]

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Cambridge	Twin Falls	La Jolla	New Orleans	Riverside	Blue Hill	Newport	Friday Harbor	Albuquerque
	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Dec. 3	186	143	166	123	179	210	164	180	257	238	247	159	177	68	324
Dec. 10	94	85	90	54	112	198	123	189	206	165	152	123	125	138	164
Dec. 17	170	107	173	82	138	146	102	99	200	145	177	110	118	45	279
Dec. 24 [1]	122	42	48	46	103	86	90	123	199	171	188	101	114	57	206

DEPARTURES FROM WEEKLY NORMALS

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Cambridge	Twin Falls	La Jolla	New Orleans	Riverside	Blue Hill	Newport	Friday Harbor	Albuquerque
Dec. 3	+26	+26	−9	+48	+71	+24		+61	+8	+33	+30	+26	+15	−14	
Dec. 10	−44	−28	−73	−27	+6	+25		+66	−24	−18	−45	−9	−11	+49	
Dec. 17	+30	−11	−4	−3	+39	−5		−18	−36	−66	−52	−18	−1	−22	
Dec. 24 [1]	−27	−77	−121	−36	−11	−56		−7	−31	+8	−22	−34	−25	−9	

ACCUMULATED DEPARTURES ON—DEC. 31, 1940

	Washington	Madison	Lincoln	Chicago	New York	Fresno	Cambridge	Twin Falls	La Jolla	New Orleans	Riverside	Blue Hill	Newport	Friday Harbor	Albuquerque
	+5,656	+5,257		+5,981	+10,269	−798				+10,796		−5,915	−2,153		

PERCENTAGE DEPARTURES FOR THE YEAR

	Washington	Madison	Lincoln	Chicago	New York	Fresno	Cambridge	Twin Falls	La Jolla	New Orleans	Riverside	Blue Hill	Newport	Friday Harbor	Albuquerque
	+4.4	+4.2		+5.6	+8.9	−0.5				+8.1		−4.9	−1.7		

[1] 8-day mean.

POSITIONS, AREAS, AND COUNTS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory.] All measurements and spot counts were made at the Naval Observatory from plates taken at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millionths of Sun's hemisphere. For each day, under longitude, latitude, area of spot or group, and spot count, are included assumed longitude of center of the disk, assumed latitude of center of the disk, total area of spots and groups, and total spot count.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
1940	h m		°	°	°	°				
Dec. 1	10 51	7062	+3	71	+14	13	218	9	VG	Mt. Wilson.
		7063	+74	142	+13	74	291	10		
		7064	+74	142	+11	74	145	4		
				(68)	(+1)		654	23		
Dec. 2	11 19	7066	−79	336	+8	79	12	1	VG	Do.
		7065	−77	338	+2	77	24	2		
		7062	+17	72	+14	22	206	4		
		(*)	+56	111	+14	57	6	2		
				(55)	(+1)		248	9		
Dec. 3	10 15	7067	−74	328	+8	74	48	2	G	U. S. Naval.
		7066	−69	333	+8	69	73	1		
		7065	−62	340	+2	62	97	4		
		7062	+36	72	+14	33	218	4		
				(42)	(+1)		436	11		
Dec. 4	11 10	7069	−86	303	+18	86	121	1	F	Do.
		7068	−63	326	−12	64	97	4		
		7067	−60	329	+8	61	97	7		
		7066	−56	333	+7	57	48	1		
		7065	−50	339	+2	50	109	4		
		7062	+42	71	+14	44	218	2		
				(29)	(0)		690	19		
Dec. 5	14 33	7069	−71	303	+18	72	170	1	G	Do.
		7068	−50	324	−11	51	170	6		
		7067	−49	325	+8	50	170	7		
		7066	−40	334	+7	41	73	1		
		7065	−33	341	+2	33	145	7		
		7062	+58	72	+14	60	145	1		
				(14)	(0)		873	23		
Dec. 6	10 50	7071	−85	278	−14	85	48	1	VG	Do.
		7069	−59	304	+18	60	73	1		
		7067	−40	323	+8	41	97	6		
		7068	−39	324	−11	40	267	10		
		7067	−36	327	+6	37	97	7		
		7066	−30	333	+6	31	48	1		
		7065	−21	342	+2	21	121	10		
		7070	−6	357	−16	18	12	2		
		7062	+69	72	+14	70	145	1		
				(3)	(0)		908	39		
Dec. 7	11 13	7072	−84	265	−7	84	24	1	VG	Mt. Wilson.
		7071	−71	278	−14	72	48	1		
		7069	−48	301	+20	51	73	1		
		7069	−47	302	+19	50	6	1		
		7067	−27	322	+9	29	121	14		
		7068	−25	324	−11	27	339	22		
		7067	−23	326	+7	25	97	7		
		7066	−15	334	+7	16	61	1		
		7065	−8	341	+3	9	12	1		
		7065	−8	341	+2	9	145	23		
		7070	+7	356	−17	19	12	5		
		7062	+83	72	+14	83	145	1		
				(349)	(0)		1,083	78		
Dec. 8	11 38	7074	−78	258	−10	79	485	1	G	U. S. Naval.
		7072	−69	267	−7	69	48	1		
		7071	−57	279	−14	58	73	1		
		7069	−35	301	+19	40	6	1		
		7069	−33	303	+19	38	73	1		
		7067	−13	323	+9	15	97	12		
		7068	−11	325	−11	16	339	15		
		7067	−8	328	+8	12	97	4		
		7066	−2	334	+8	8	48	1		
		7065	+7	343	+3	7	73	4		
		7070	+20	356	−17	26	12	4		
		7073	+22	358	−7	23	12	3		
				(336)	(0)		1,363	48		

POSITIONS, AREAS, AND COUNTS OF SUN SPOTS—Con.

Date	Eastern standard time	Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
	h m		°	°	°	°				
Dec. 9	13 23	7074	−65	257	−10	67	533	6	VG	U. S. Naval.
		7072	−60	262	−6	61	73	2		
		7072	−54	268	−7	55	121	7		
		7071	−44	278	−14	46	48	2		
		7069	−20	302	+20	27	97	4		
		7076	−18	304	+1	18	48	4		
		(*)	+1	323	+10	10	48	3		
		7068	+3	325	−11	12	485	15		
		7067	+8	330	+9	13	97	5		
		7066	+12	334	+8	15	48	1		
		7075	+19	341	+19	27	97	7		
		7065	+22	344	+2	22	73	1		
				(322)	(0)		1,768	57		
Dec. 10	12 54	7077	−70	239	+13	71	24	1	VG	Do.
		7077	−70	239	+11	70	97	6		
		7074	−52	257	−11	53	436	11		
		7072	−47	262	−6	48	121	7		
		7072	−41	268	−7	42	121	13		
		7071	−30	279	−14	34	48	3		
		7069	−7	302	+20	22	97	9		
		7076	−5	304	+1	5	121	12		
		(*)	+13	322	+10	16	24	4		
		7068	+16	325	−11	20	436	20		
		7067	+22	331	+9	23	145	11		
		7066	+26	335	+8	28	36	1		
		7075	+32	341	+19	37	194	14		
		7065	+35	344	+1	35	73	7		
		7073	+51	0	−7	52	73	5		
				(309)	(0)		2,046	124		
Dec. 11	13 21	7077	−57	238	+10	58	145	8	G	Do.
		7074	−39	256	−11	40	388	3		
		7072	−30	265	−7	32	145	9		
		7071	−17	278	−14	22	24	1		
		7079	−4	291	−5	6	12	1		
		7069	+7	302	+19	21	61	1		
		7076	+9	304	+1	9	145	8		
		7078	+9	304	−2	9	24	1		
		7068	+29	324	−11	31	291	10		
		7067	+37	332	+9	38	170	13		
		7066	+39	334	+8	40	24	1		
		7075	+46	341	+20	50	315	5		
		7065	+48	343	+1	48	73	3		
		7073	+63	358	−7	64	12	1		
				(295)	(0)		1,829	65		
Dec. 12	14 0	7077	−43	239	+10	44	194	14	G	Do.
		7074	−31	251	−10	32	12	1		
		7074	−25	257	−10	26	315	3		
		7072	−17	265	−7	19	121	9		
		7069	+21	303	+18	28	48	1		
		7076	+23	305	+1	23	194	15		
		7078	+23	305	−3	23	48	4		
		7068	+43	325	−12	44	218	7		
		7067	+50	332	+9	51	170	6		
		7075	+60	342	+19	63	315	8		
		7065	+62	344	+1	62	12	1		
				(282)	(−1)		1,647	69		
Dec. 15	14 51	7082	−59	183	−11	59	97	2	F	Mt. Wilson.
		7081	−48	194	+12	50	73	5		
		7077	−4	238	+11	13	194	35		
		7077	+3	245	+12	13	194	15		
		7084	+14	256	−20	23	6	1		
		7074	+17	259	−10	20	267	2		
		7083	+21	263	+13	25	6	2		
		7072	+29	271	−8	30	12	4		
		7071	+38	280	−12	40	61	11		
		7076	+67	309	+3	67	194	21		
		7078	+69	311	−5	69	24	1		
		7080	+86	328	+3	86	97	1		
				(242)	(−1)		1,225	90		
Dec. 17	11 43	7082	−32	185	−11	33	97	4	F	U. S. Naval.
		7081	−22	195	+11	25	48	1		
		7077	+23	240	+11	26	73	7		
		7077	+28	245	+12	31	194	4		
		7074	+41	258	−10	42	242	2		
		7084	+41	258	−18	44	24	3		
		(*)	+50	267	+11	52	48	4		
		7071	+63	280	−11	63	48	3		
				(217)	(−1)		774	28		

POSITIONS, AREAS, AND COUNTS OF SUN SPOTS—Con.

Date	Eastern standard time		Mount Wilson group No.	Heliographic: Difference in longitude	Heliographic: Longitude	Heliographic: Latitude	Heliographic: Distance from center of disk	Area of spot or group	Spot count	Plate quality	Observatory
	h	m		°	°	°	°				
Dec. 18	11	17	7085	−81	123	−13	81	24	1	G	U. S. Naval.
			7082	−19	185	−11	21	61	1		
			7081	−10	194	+11	16	48	4		
			7077	+36	240	+11	38	73	8		
			7077	+42	246	+12	44	218	1		
			7074	+55	259	−10	55	242	4		
			7084	+55	259	−17	56	12	1		
			(*)	+63	267	+11	65	73	5		
					(204)	(−1)		751	25		
Dec. 19	12	56	7085	−68	122	−13	69	97	4	G	Do.
			7082	−11	179	−3	11	12	1		
			7082	−6	184	−10	10	61	1		
			7077	+50	240	+11	52	24	8		
			7077	+57	247	+12	59	291	3		
			7074	+69	259	−9	69	218	3		
			(*)	+75	265	+11	77	18	1		
					(190)	(−2)		721	21		
Dec. 20	13	22	7085	−54	123	−13	55	194	12	G	Do.
			7082	+8	185	−10	12	48	1		
			7077	+57	234	+12	59	291	4		
			7074	+81	258	−9	81	145	2		
					(177)	(−2)		678	19		
Dec. 21	12	35	7087	−75	89	+8	76	48	1	G	Do.
			7085	−41	123	−13	42	339	13		
			7082	+21	185	−10	22	48	1		
			7086	+57	221	−11	58	24	3		
			7077	+81	245	+12	82	48	1		
					(164)	(−2)		507	19		
Dec. 22	11	33	7087	−61	90	+8	62	73	1	F	Do.
			7085	−27	124	−13	30	339	13		
			7082	+33	184	−10	34	24	1		
					(151)	(−2)		436	15		
Dec. 23	11	6	7087	−48	90	+8	49	73	2	F	Do.
			7085	−14	124	−13	18	388	21		
			7089	+15	153	+9	19	48	6		
			7088	+70	208	+13	72	24	1		
					(138)	(−2)		533	30		
Dec. 24	11	52	7087	−35	90	+8	37	48	1	F	Do.
			7085	−1	124	−13	11	242	15		
			7089	+26	151	+9	29	48	7		
			7088	+84	209	+13	86	97	1		
					(125)	(−2)		435	24		
Dec. 25	11	22	7087	−21	91	+8	24	48	2	F	Do.
			7085	+12	124	−13	16	218	12		
			7089	+38	150	+10	40	48	2		
			7090	+48	160	+13	50	97	5		
					(112)	(−2)		411	21		
Dec. 26	11	35	7091	−35	64	+14	39	12	3	VG	Mt. Wilson.
			7087	−7	92	+8	13	61	5		
			7085	+25	124	−13	26	218	14		
			7089	+51	150	+8	52	24	4		
			7090	+63	162	+12	65	194	5		
					(99)	(−2)		509	31		
Dec. 27	11	1	7087	+6	92	+7	11	61	12	VG	Mt. Wilson.
			7085	+38	124	−14	40	339	33		
			7090	+76	162	+12	77	194	5		
					(86)	(−2)		594	50		
Dec. 29	13	43	7095	−84	334	+7	84	145	1	F	U. S. Naval.
			7093	−78	340	+18	79	48	1		
			7094	−76	342	+12	77	48	1		
			7092	−57	1	−9	58	145	5		
			7087	+37	95	+8	39	48	4		
			7085	+68	126	−13	69	145	4		
					(58)	(−3)		579	16		
Dec. 30	13	45	7095	−60	336	+8	69	145	2	F	Do.
			7093	−64	341	+18	67	48	1		
			7094	−63	342	+12	65	48	1		
			7092	−43	2	−9	43	170	5		
			7087	+49	94	+7	50	48	4		
			7085	+79	124	−13	79	48	3		
					(45)	(−3)		507	16		
Dec. 31	12	57	7095	−56	336	+7	57	121	5	G	Do.
			7093	−52	340	+18	56	48	1		
			7094	−50	342	+12	53	48	1		
			7092	−29	3	−9	25	242	9		
			7087	+62	94	+7	63	12	3		
					(32)	(−3)		471	19		

Mean daily area for 27 days ------ =840.

*=Not numbered.
VG=very good; G=good; F=fair; P=poor.

PROVISIONAL RELATIVE SUNSPOT NUMBERS

Dependent on observations at Zurich only. Data furnished through the courtesy of Prof. W. Brunner, Eidgen. Sternwarte, Zurich]

November 1940	Relative numbers	November 1940	Relative numbers	November 1940	Relative numbers
1	*38	11	60	21	34
2	41	12	*a* 66	22	16
3	**Ec* 64	13	*Mc* 99	23	**Eac* 27
4	*a* 61	14	*Eac* 70	24	**Mc* 36
5	67	15		25	*d* 56
6	43	16	*a* 100	26	53
7	56	17	88	27	*Mc* 52
8	*Eac* 67	18	87	28	*54
9	76	19	65	29	42
10		20	47	30	31

Mean, 28 days=57.0

*=Observed at Locarno.
a=Passage of an average-sized group through the central meridian.
b=Passage of a large group through the central meridian.
c=New formation of a group developing into a middle-size or large center of activity: E, on the eastern part of the sun's disk; W, on the western part; M, in the central-circle zone.
d=Entrance of a large or average-sized center of activity on the east limb.

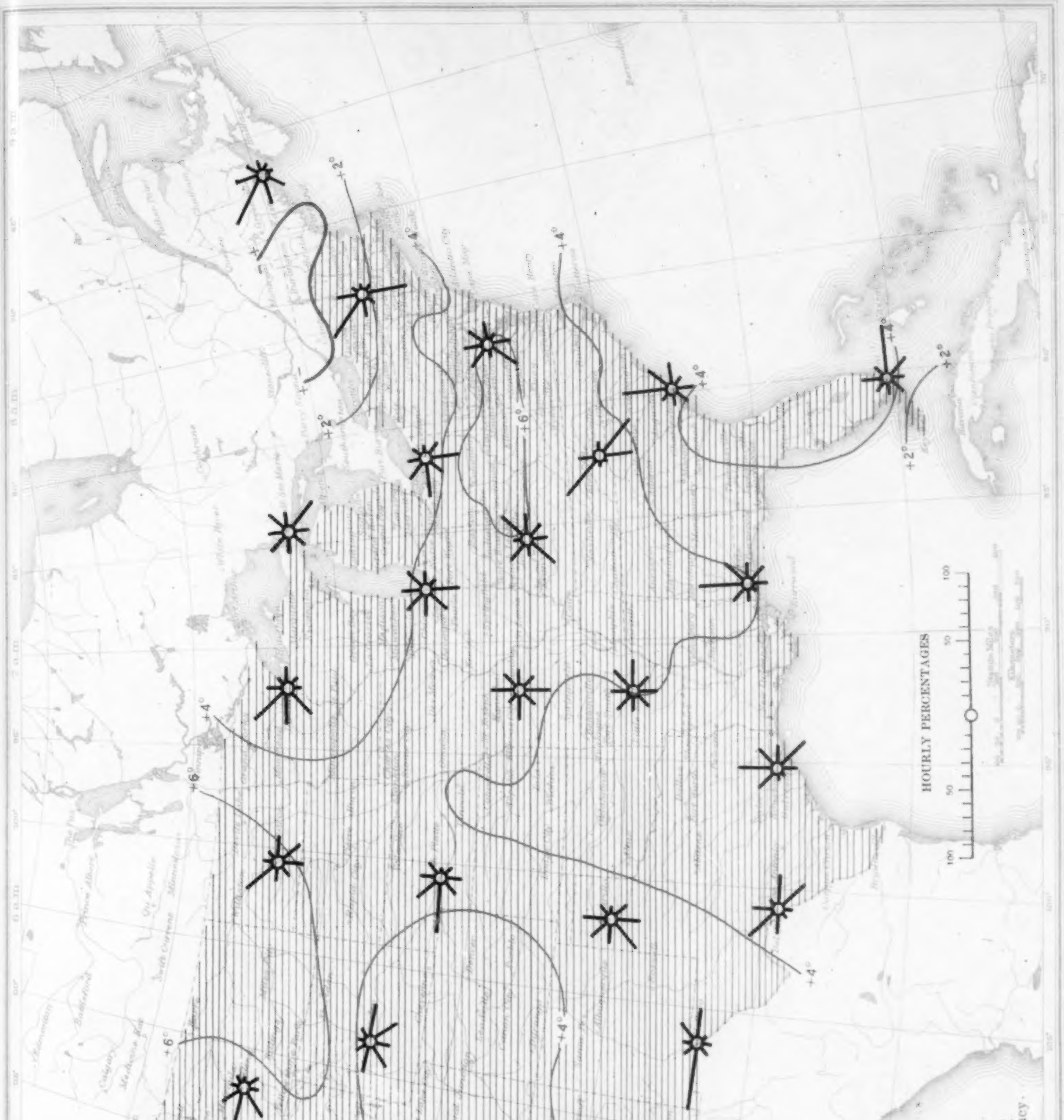
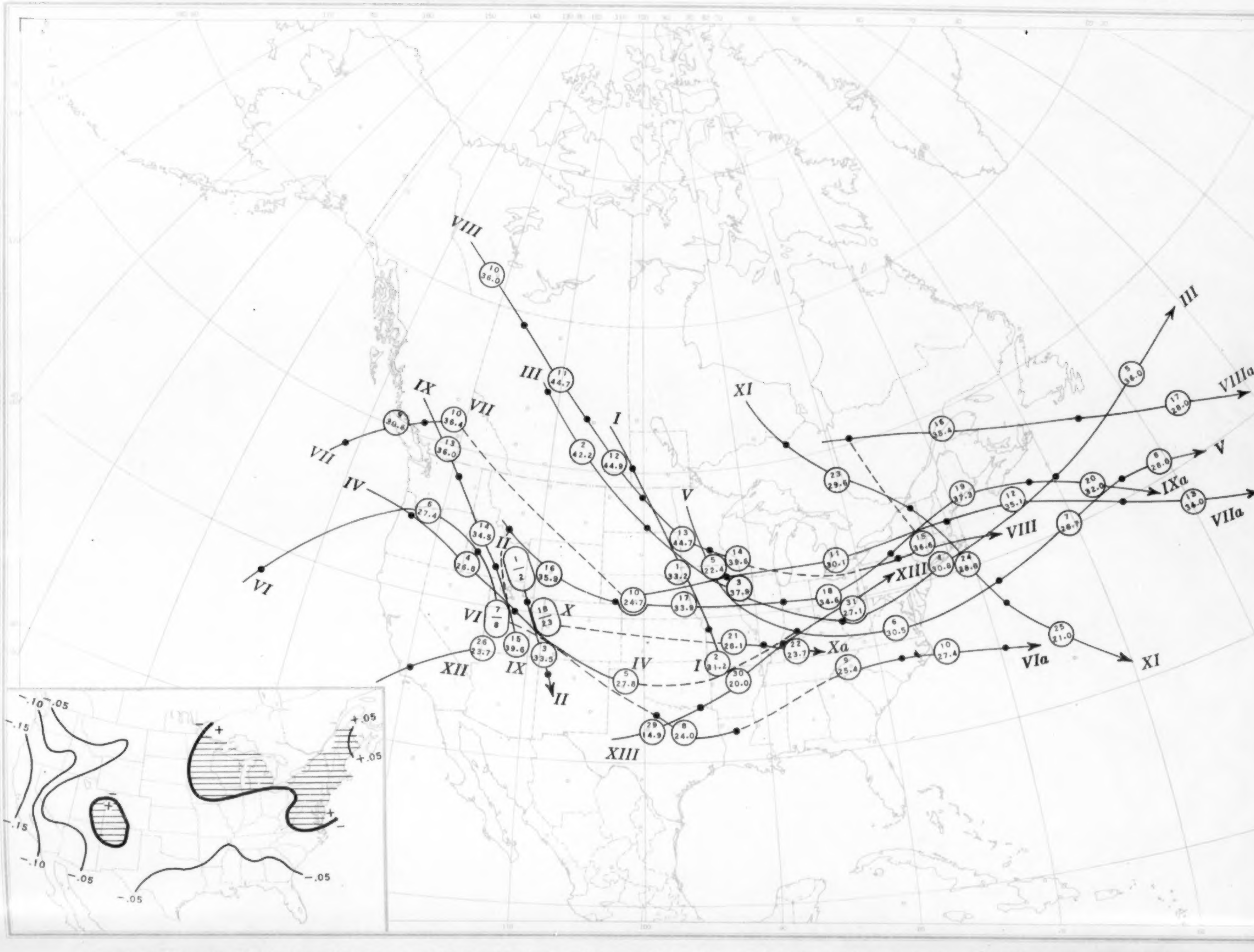


Chart I. Departure (°F.) of the Mean Temperature from the Normal, and Wind Roses for Selected Stations, December 1940

Chart II. Tracks of Centers of Anticyclones, December 1940. (Inset) Departure of Monthly Mean Pressure from Normal

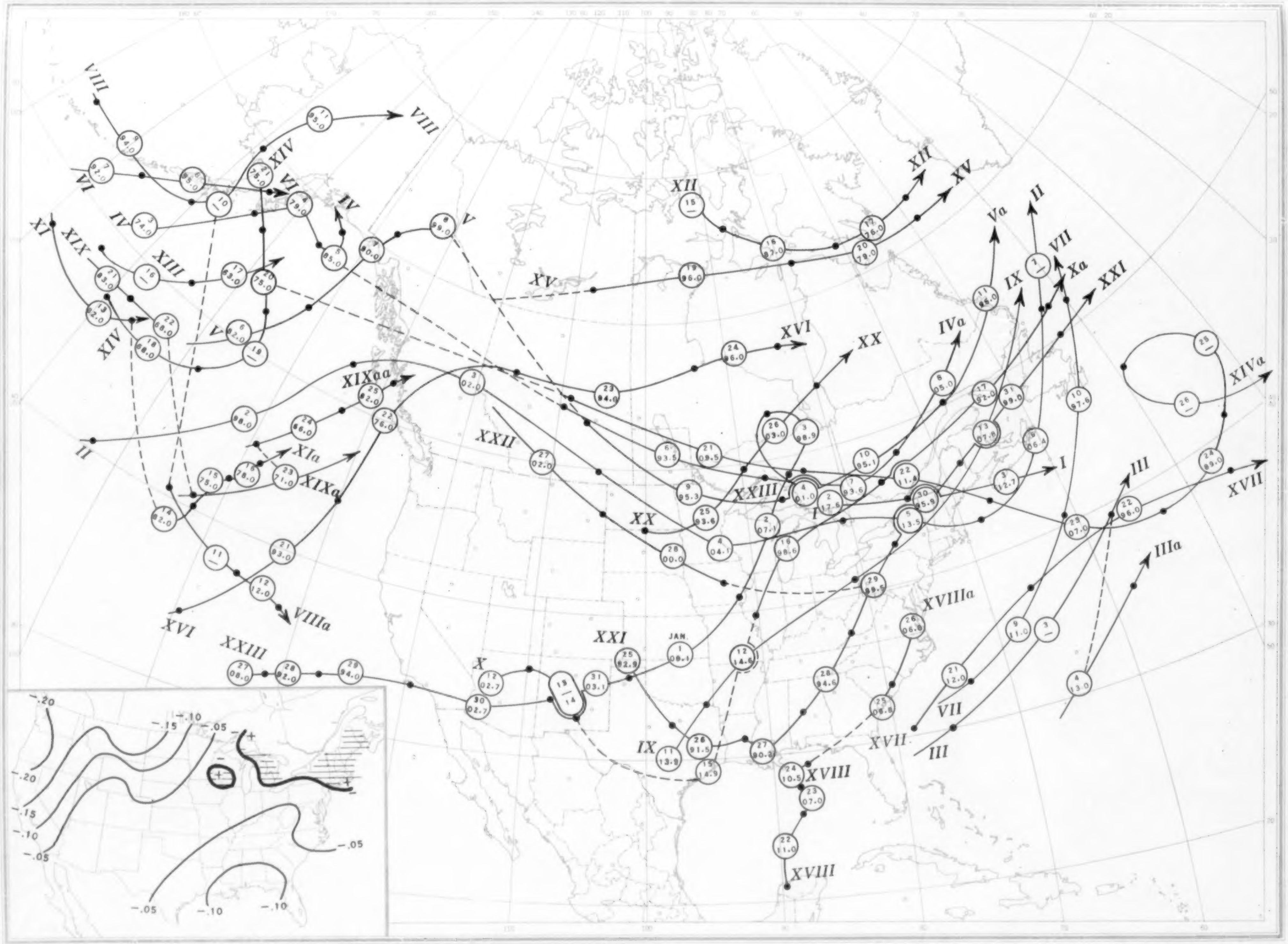


Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, December 1940. (Inset) Change in Mean Pressure from Preceding Month

Circle indicates position of anticyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of anticyclone at 7:30 p. m. (75th meridian time).

Chart III. Tracks of Centers of Cyclones, December 1940. (Inset) Change in Mean Pressure from Preceding Month



Circle indicates position of cyclone at 7:30 a. m. (75th meridian time), with barometric reading. Dot indicates position of cyclone at 7:30 p. m. (75th meridian time).

Chart IV. Percentage of Clear Sky Between Sunrise and Sunset, December 1940

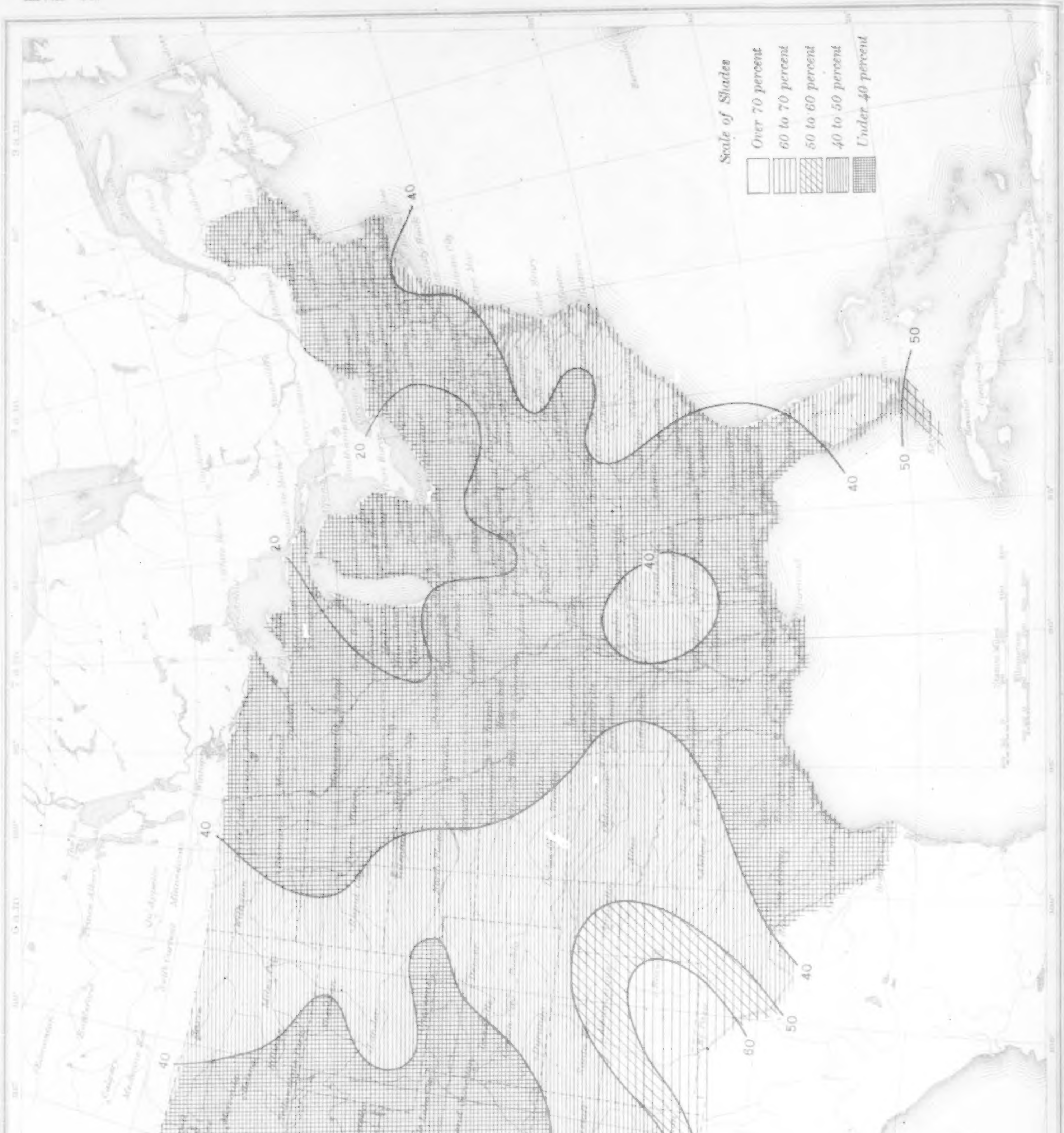


Chart V. Total Precipitation, Inches, December 1940. (Inset) Departure of Precipitation from Normal

Chart V. Total Precipitation, Inches, December 1940. (Inset) Departure of Precipitation from Normal

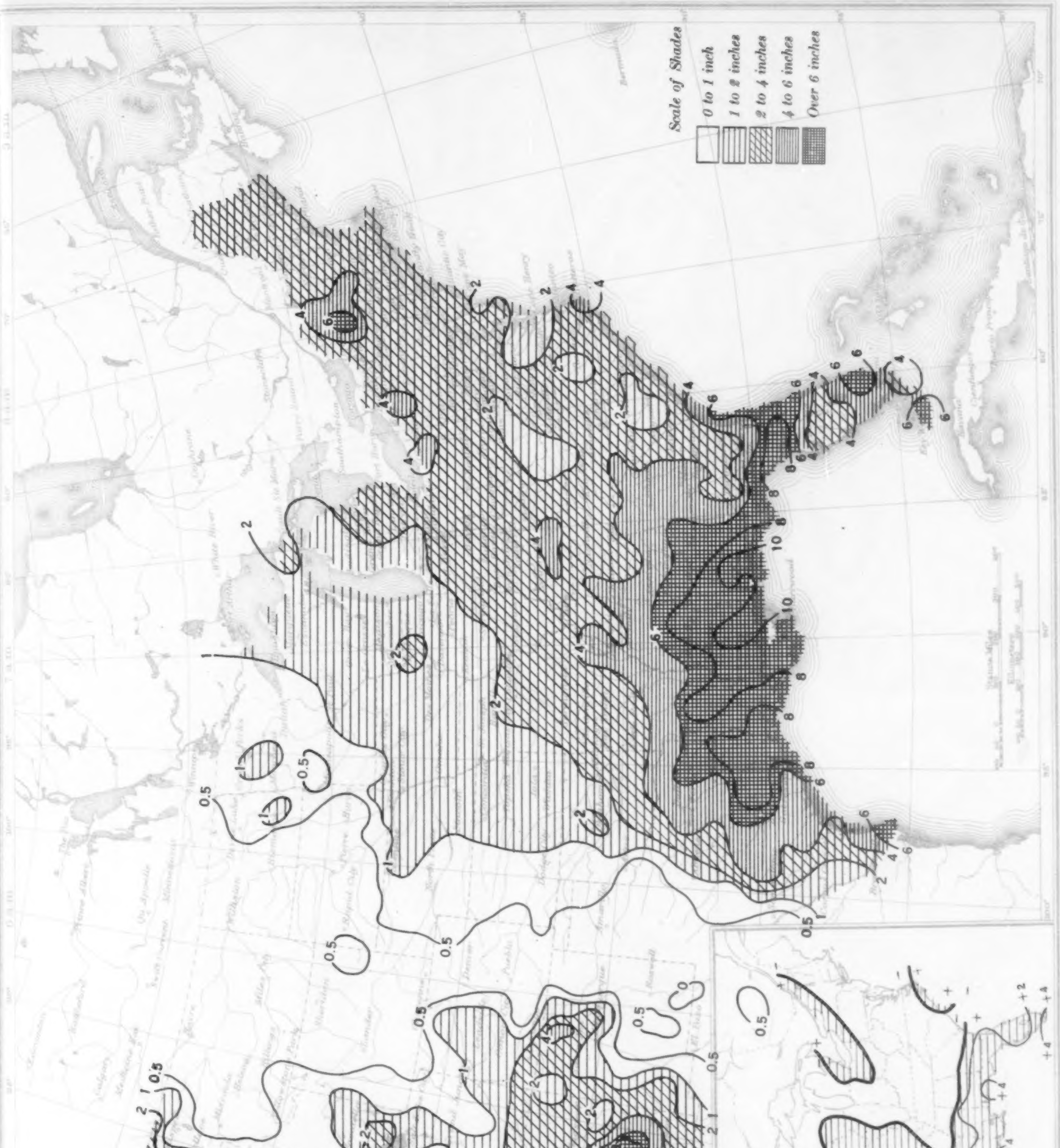


Chart VI. Isobars at Sea Level and Isotherms at Surface; Prevailing Winds, December 1940

Chart VII. Total Snowfall, Inches, December 1940. (Inset) Depth of Snow on the Ground at 7:30 p.m., Monday, December 30, 1940

Chart VII. Total Snowfall, Inches, December 1940. (Inset) Depth of Snow on the Ground at 7:30 p.m., Monday, December 30, 1940

Chart VIII. Isobars (mb) for 1,524 Meters (5,000 ft.) and Isotherms (°C.) and Resultant Winds for 1,500 Meters (m. s. l.) December 1940

Isobars and isotherms based on radiosonde observations at 1:00 a. m. (E. S. T.) and winds based on pilot-balloon observations at 5:00 a. m. (E. S. T.).

Chart VIII. Isobars (mb) for 1,524 Meters (5,000 ft.) and Isotherms (°C.) and Resultant Winds for 1,500 Meters (m. s. l.) December 1940

Isobars and isotherms based on radiosonde observations at 1:00 a. m. (E. S. T.) and winds based on pilot-balloon observations at 5:00 a. m. (E. S. T.).

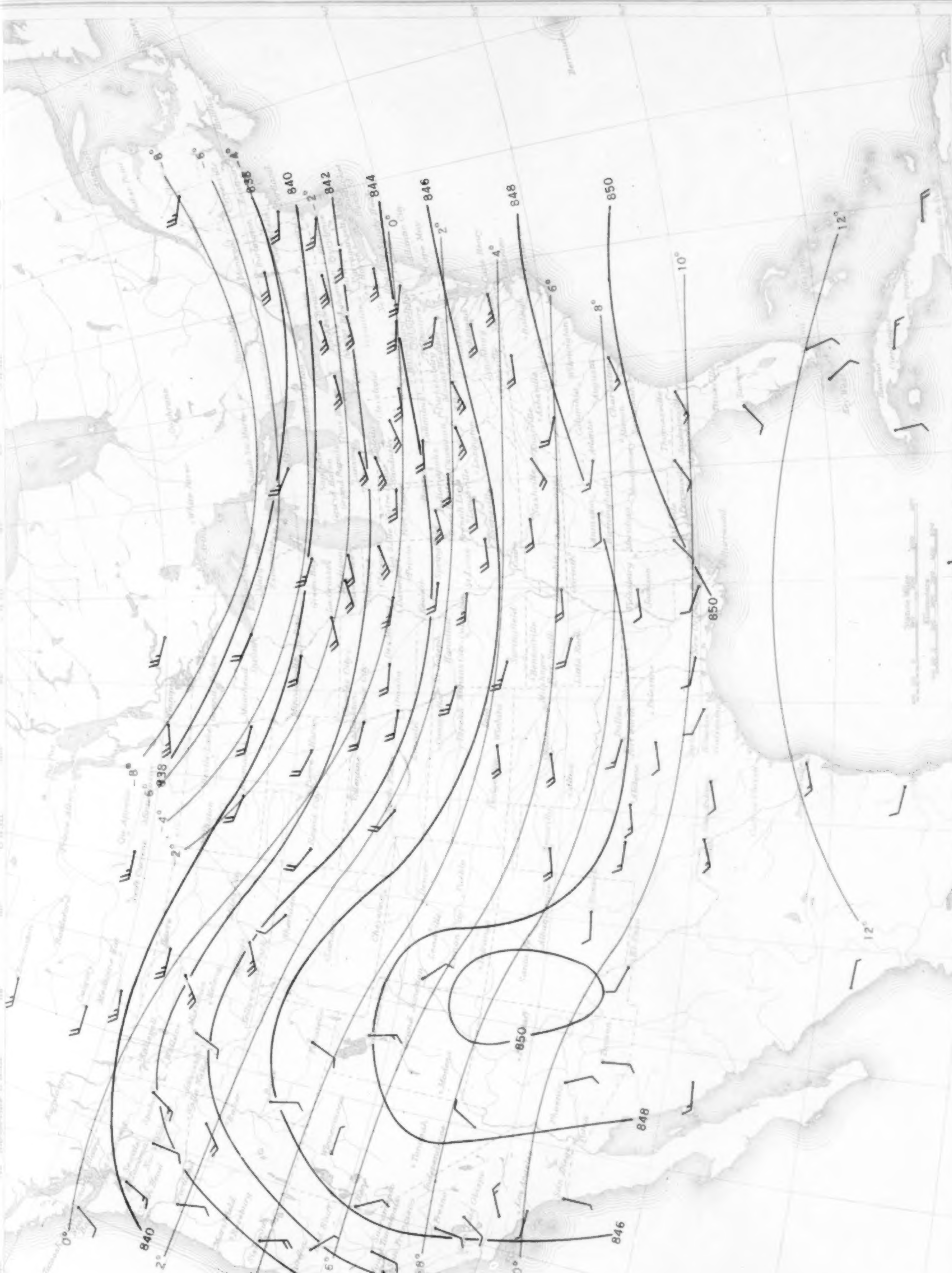


Chart IX. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T) and Resultant Winds 5:00 a.m. (E.S.T.) for 3,000 Meters (m.s.l.) December 1940

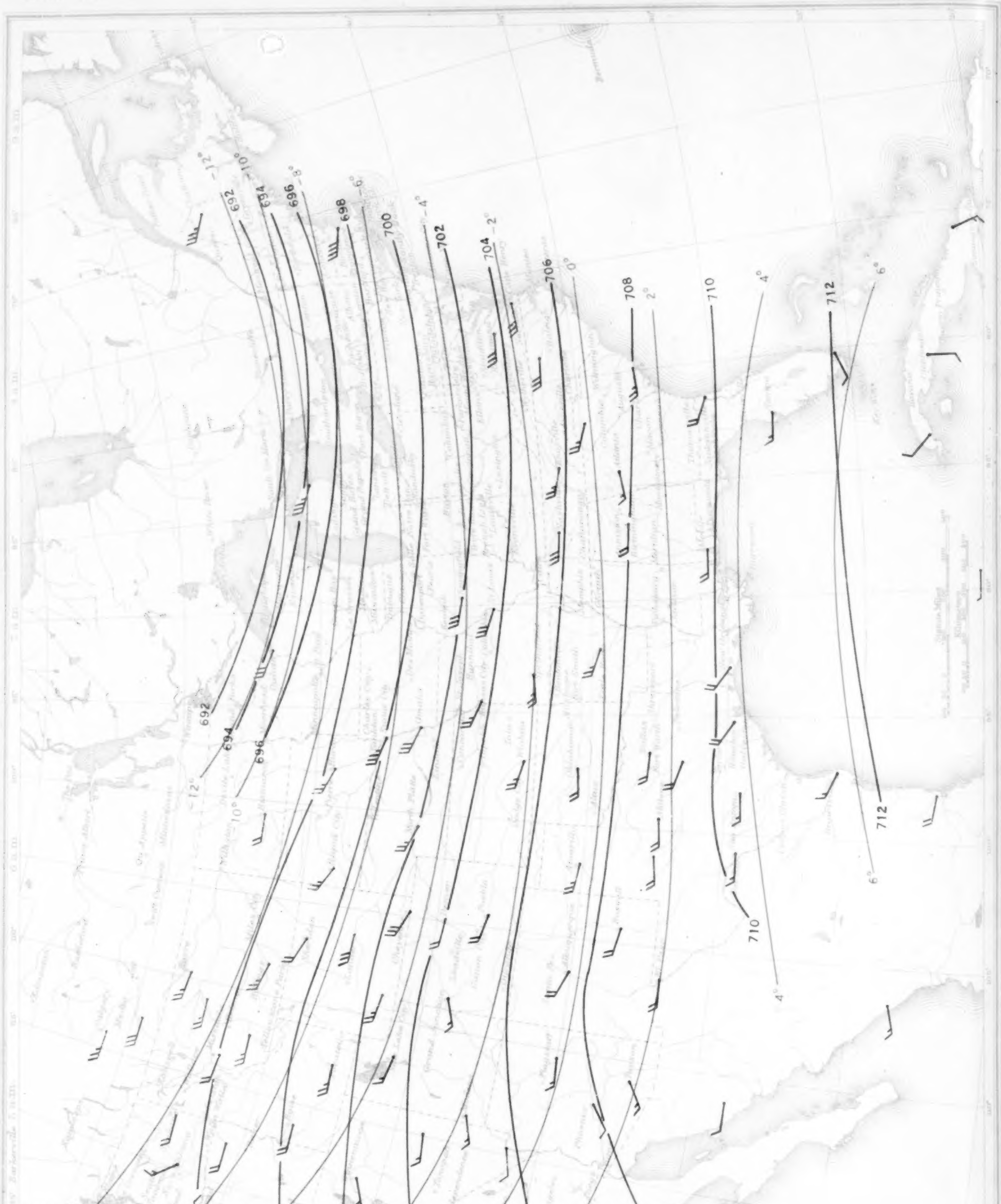


Chart X. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T.) and Resultant Winds 5:00 p.m. (E.S.T.) for 5,000 Meters (m.s.l.) December 1940

Chart X. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E. S. T.) and Resultant Winds 5:00 p.m. (E. S. T.) for 5,000 Meters (m. s. l.) December 1940

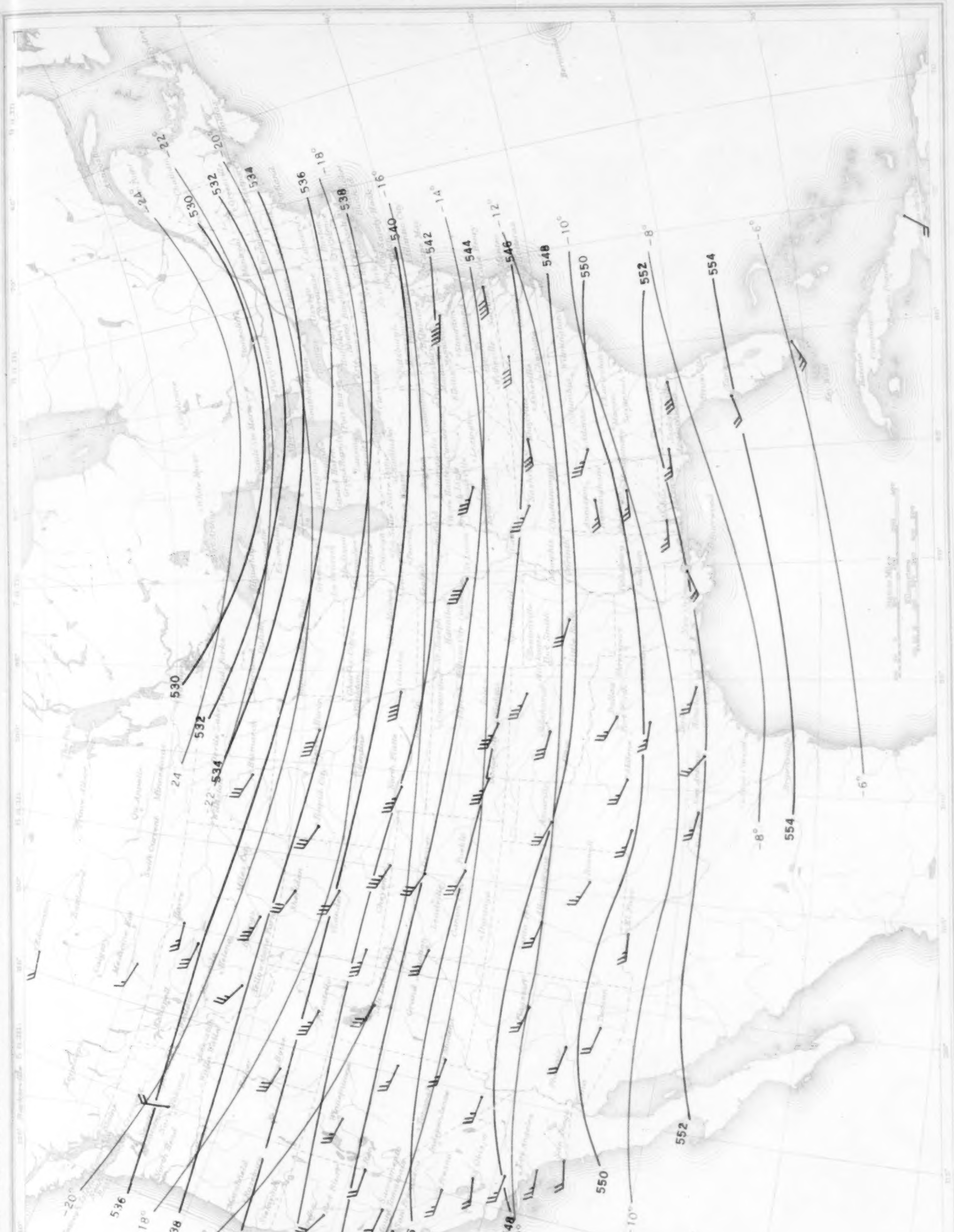


Chart XI. Isobars (mb) Isotherms (°C.) 1:00 a.m. (E.S.T.) and Resultant Winds 5:00 p.m. (E.S.T.) for 10,000 Meters (m.s.l.) December 1940

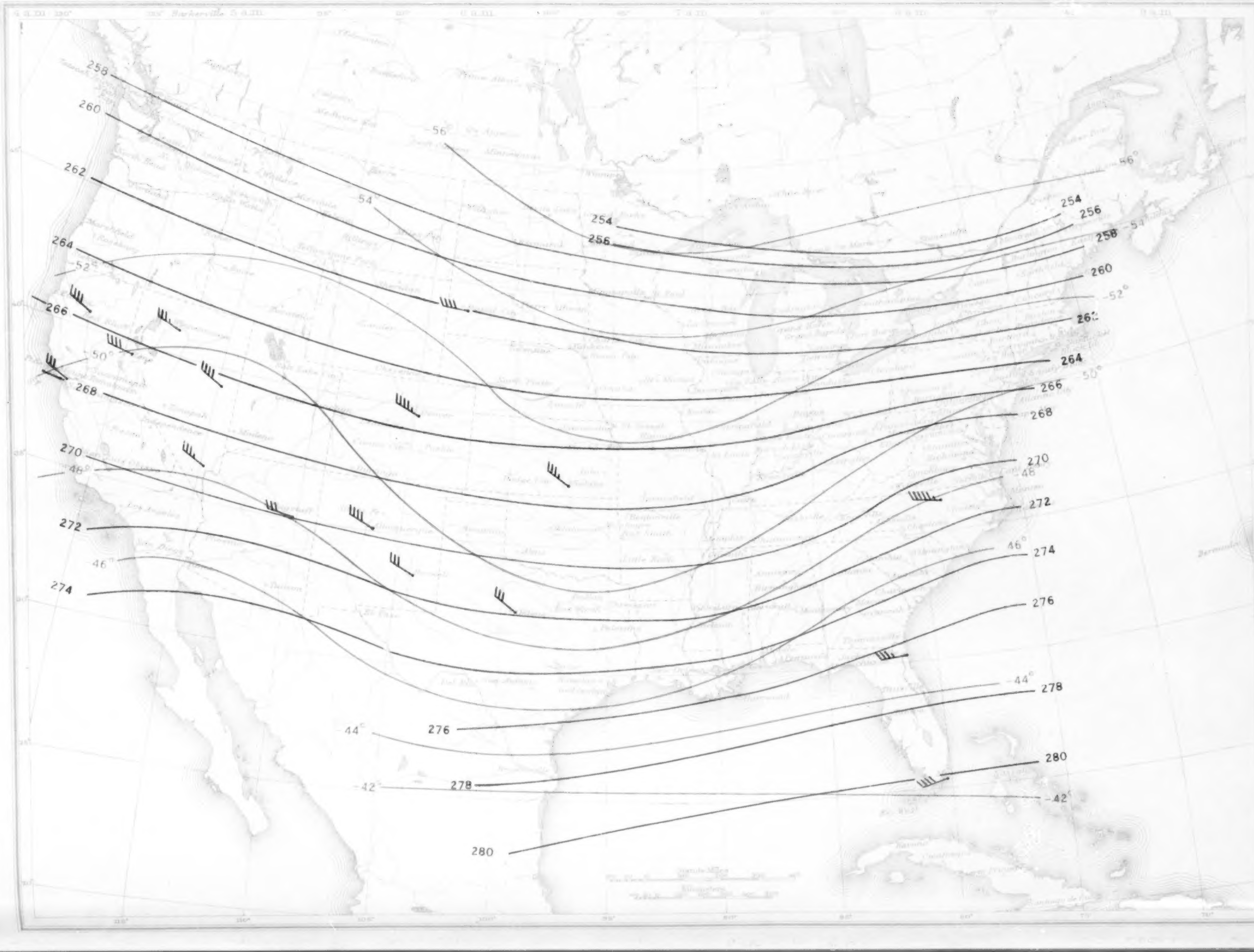


Chart XII. Mean Isentropic Chart, December 1940 (Potential Temperature 298° A.)

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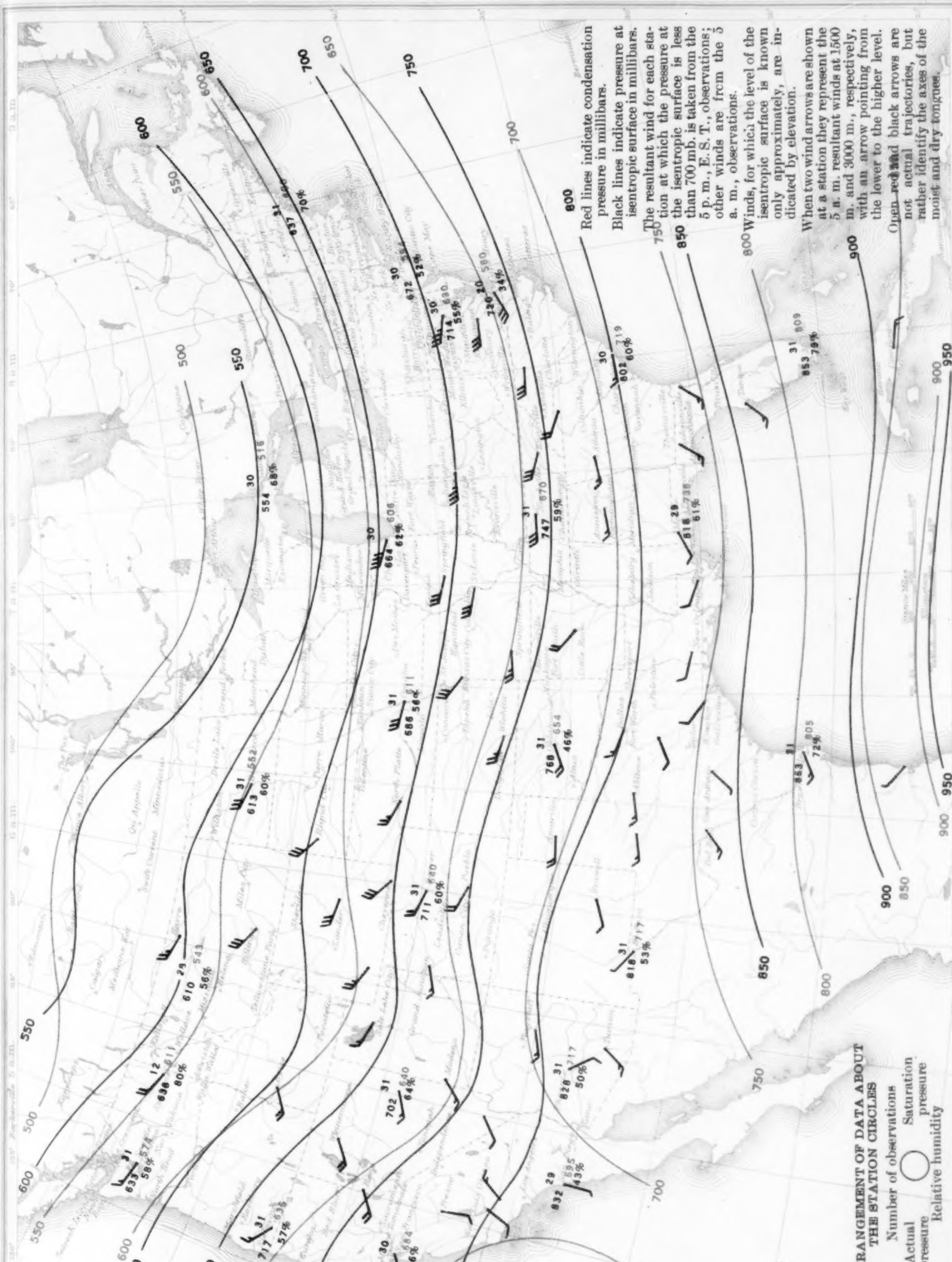
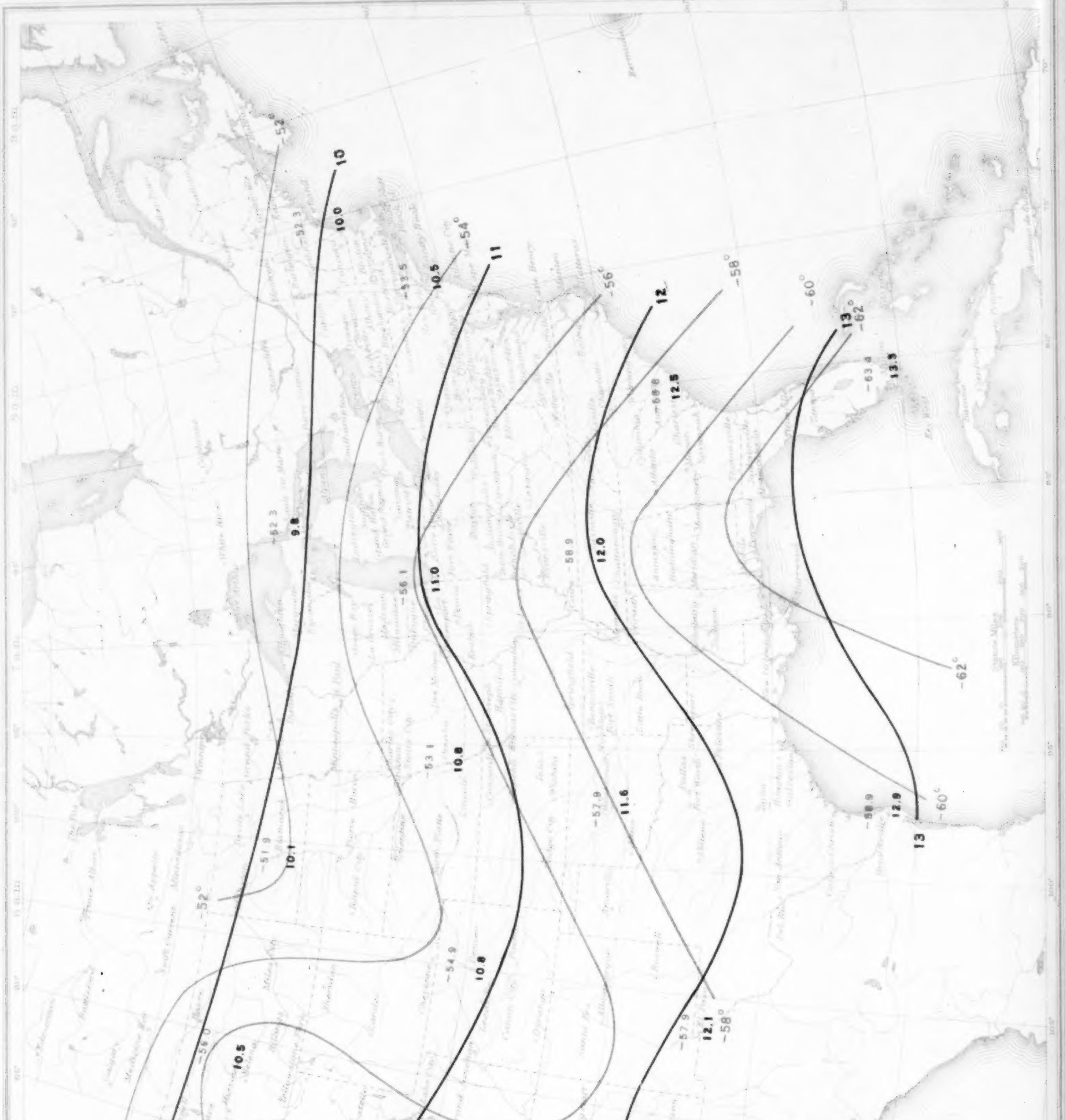


Chart XIII. Mean Tropopause Data, Altitude (km.) (m. s. l.) Temperature (°C.) December 1940

(Data from table 4)



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